March-April 1954

METAL TREATING

MTI
MASTER CRAFTSMEN
METAL TREATING INSTITUTE

The new Metallurgical, Inc., plant in Minneapolis is described in this issue. See Institute News.

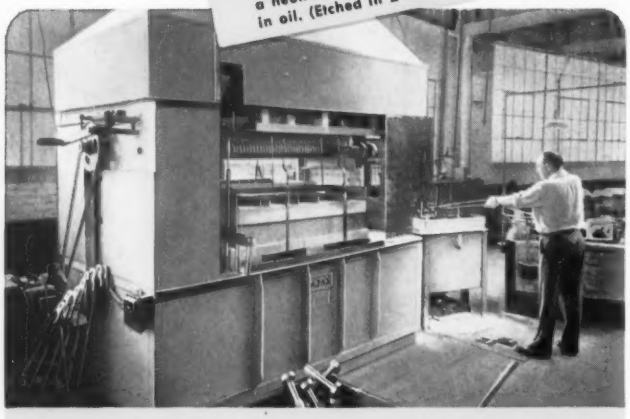
THE *Only* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

NEUTRAL HARDENING

means just what it says . . .

No Scale
No Decarb

Photomicrograph showing absence of scale or decarburization in a section of S.A.E. 1085 Steel (X100) hardened at 1500° F. in a neutral salt bath and quenched in oil. (Etched in 2% Nital.)



Automotive spline shafts being heated in a neutral salt bath equipped with a screw-conveyor mechanism. Temperature at the work is held within 5°F., even in this relatively large bath — 6 ft. long, 2 ft. wide and 2 ft. deep.

For more information on AJAX Electric Salt Bath Furnaces and their many uses — hardening, annealing, brazing, tempering, cleaning, quenching, etc. — metallurgists and metalworking executives are invited to write on their firm's letterhead for the new 72-page Booklet No. 116B.

AJAX ELECTRIC COMPANY

940 Frankford Avenue, Philadelphia 23, Pa.

The World's Largest Manufacturer of Electric Heat Treating Furnaces Exclusively!

Associate Companies:
Ajax Electric Furnace Corp. — Ajax Engineering Corp.
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AJAX
INDUCTOTHERM

ELECTRIC SALT BATH FURNACES

. . . and an amazing volume of work can be treated in small, relatively inexpensive salt bath equipment.

A neutral salt bath provides an ideal means of heating carbon or alloy steel parts without any deleterious effect on the surface, such as scaling, pitting, carburizing or decarburizing. The bath completely seals out all air while work is heating . . . and a thin film of salt remains when work is removed, protecting it right up to the instant of quenching.

All "protective atmospheres," gas generating equipment and specially trained operators required for their use are eliminated . . . with corresponding savings in initial expense, operating costs and floor space requirements.

Heating cycles are 4 to 6 times faster than in atmosphere or radiant type furnaces — enabling small furnaces to handle a large volume of work — because heat is transferred by conduction rather than by convection or radiation, all surfaces of the work being in direct physical contact with the molten salt. Heating, therefore, is both rapid and uniform . . . eliminating the cause of most distortion.

Unique internal heating principle of the AJAX furnace — utilizing patented, closely-spaced, immersed electrodes — produces an automatic electrodynamic stirring action within the bath which contributes to faster heating of the work and assures a temperature variation of less than 5° F. throughout the bath.

This internal heating feature also permits use of long-lived ceramic pots, avoiding contamination of neutral baths by metallic oxides produced by metal pots.

The advantages of hardening in a neutral salt bath can be further enhanced by use of an isothermal salt bath quench (martempering or austempering) to hold distortion to a minimum and eliminate quench cracking.

MASTER CRAFTSMEN
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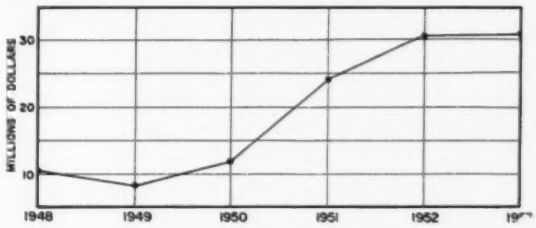
METAL TREATING

EDITORIAL

A GROWING GIANT

When we plotted the chart shown on this page to get a quick picture of the growth and expanding importance of the commercial heat treating industry, we were frankly surprised. Even allowing for inflation the figures reveal that the metal working industry is becoming more and more closely allied to and dependent upon the heat treatment of metals as an integral part of production.

If the volume of "in-plant" or departmental operations which has been added or expanded in manufacturing plants were included, the figures would doubtless begin to look like the Congressional tax bill.



The heat treating industry is truly "a growing giant" and is steadily attaining national recognition not only by all industry but in Washington, by the press, and by the wordl of science.

There is, we are glad to point out, increasing evidence that our giant is not a "sleeping" one. Modern plants (see page 24) are spreading throughout the country. Modern business practices, advertising (see pages 20-21), new products, scientific developments (see page 10), all piece together to present an amazing picture of growth, value, importance.

All connected with heat treating today can well be proud of the fact that without this "growing giant" many of the world's most vital and important products simply would not exist.

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DEPARTMENTS

High Pressure

NITRIDING FOR THE HEAT TREATER

By **R. L. CHENAULT,** *Chief Research Engineer*
and
G. E. MOHNKERN, *Research Engineer*
Oil Well Supply Div., U. S. Steel Corp.
Oil City, Pennsylvania

The high-pressure method of nitriding, recently designated as "Nitrocyle," is readily adaptable to small shops, as well as large scale operations, without the necessity for unusual operating skill. It is described here in considerable detail in order to acquaint the heat treater with the commercial possibilities of this casehardening procedure. While the process is especially adaptable to the nitriding of the inner surfaces of tubular parts, all surfaces of relatively small items, which can be inserted in containers capable of holding pressures of a few hundred psi at approximately 1000°F., can be casehardened equally as well. Conventional nitriding with its advantages and disadvantages is well known and requires no explanation here; hence this paper will deal only with the subject of nitriding under pressure.

One outstanding advantage of nitriding under pressure is that the operating temperature and pressure existing during this process causes the inactive nitrogen and hydrogen to unite to form ammonia instead of being vented as in the conventional methods. The dissociation of ammonia takes place in accordance with equation (A):

$$(A) \quad 2\ NH_3 \rightarrow N_2 \quad 3H_2$$

However, there must be a period of time when nitrogen and hydrogen exist in the atomic state. It is during this period that the nitrogen is chemically active and combines with various constituents of many alloy steels to form very hard nitrides. Only a very small percentage of the nitrogen is accounted for in this manner while the balance rapidly combines to form molecular nitrogen (N_2) which is inert. The hydrogen which also is liberated apparently takes no part in the nitriding process but rapidly returns to stable molecular hydrogen.

Referring to equation (B), we see immediately the possibilities of molecular nitrogen and molecular hydrogen combining to form ammonia providing conditions are suitable. These are the conditions which exist during pressure nitriding.

$$(B) \quad 2\ NH_3 \rightleftarrows N_2 \quad 3H_2$$

The reaction being reversible, as indicated, the nitrogen atoms which do not combine with the steel during any particular dissociation cycle will eventually recombine with hydrogen to form ammonia; and another opportunity to combine the nitrogen atom with the steel will be made available. This reaction may go on until all of the nitrogen is eventually combined with the steel.

We have used two general methods of pressure nitriding with equal success; in one case the ammonia is introduced into the vessel in the liquid state and in the vapor state in the other. The choice of the method depends on the type of parts to be nitrided. Fig. 1 shows the arrangement used for nitriding the inner surface of alloy steel tubes. In this case, the ammonia is introduced by means of a small steel capsule containing the proper quantity of liquid ammonia to nitride the inner wall of the tube to the depth desired. The cover of the ammonia capsule is drilled with a small hole which is plugged with a low melting point solder. The ammonia capsule is then placed into the steel tube and end plates, or plugs, are welded onto the tubes as shown. As the tube is heated in the furnace, the soft solder melts and the ammonia vaporizes and expands throughout the interior of the tube to be nitrided. Other methods of releasing ammonia from the capsule, as a result of pressure, temperature, or mechanical manipulations, can be utilized—but the soft solder plug has proven entirely satisfactory. Such tubes can be rotated on

This article is an abstract of a talk presented by Mr. Mohnkern at the Annual Meeting of the Metal Treating Institute held in Cleveland, Ohio during October, 1953.

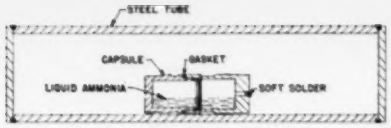


Fig. 1—Method of using an ammonia filled capsule for pressure nitriding the inner surface of tubes.

level bearings or rolled through a furnace for nitriding and straightness can be maintained under such conditions; that is, the tubes will come out of the nitriding process as straight, or straighter, than when nitriding was started.

Fig. 2 illustrates the construction of a refrigerator used for filling capsules with liquid ammonia. The refrigerant used is solid CO_2 in a bath of acetone to provide good heat transfer. The soft steel capsules are cooled down in this refrigerator to a temperature of about -50° F., where the liquid ammonia can be handled with very little inconvenience. After filling, the capsule is taken out and clamped in a vise while the cap is screwed on and tightened onto a gasket to prevent leakage. After cooling to -50° F., the ammonia does not evaporate fast enough to constitute a serious hazard during the time required to fill and close the capsule. Inasmuch as liquid ammonia has a very high coefficient of expansion at high temperature it is imperative to leave a considerable space for expansion of the liquid as indicated.

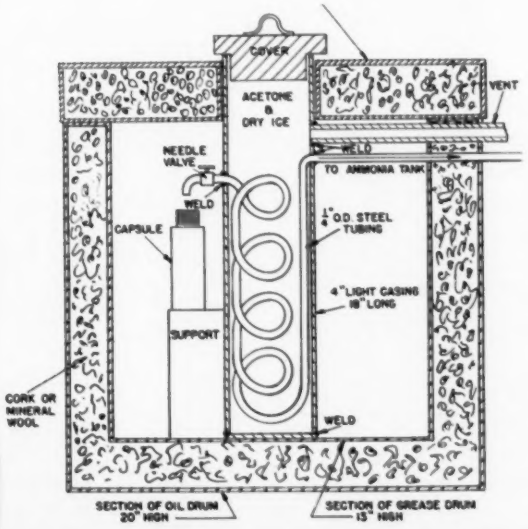


Fig. 2—This is the equipment used to fill capsule with liquid ammonia for use as shown in Fig. 1. A temperature of −50°F. is maintained in the refrigerator.

Fig. 3 is an illustration of a method where ammonia is admitted to the nitriding reservoir in a vapor state. This method does not require metering of the liquid, or vapor, to obtain the proper ammonia charge since it is obtained by controlling the pressure which, in turn, is controlled by the temperature of the liquid ammonia in the tank. The ammonia container (1) is maintained at a controlled temperature by a water bath which surrounds it. The nitriding vessel (3) is placed in a suitable furnace (4) and may contain parts (5) to be nitrided; or, in some cases, it may be desirable to nitride the inner walls of the vessel (3) only.

The proper quantity of ammonia vapor is admitted to the nitriding vessel simply by controlling the pressure within the nitriding vessel (3), as indicated by the pressure gauge (6). When the proper charge of ammonia has been obtained, the valve (7) may be closed and the ammonia reservoir (1) disconnected by disengaging the union (8). The nitriding cycle can be completed with the ammonia tank permanently open to the nitriding vessel through the valves (7) and (9) and the connecting tube (10). However, the method also permits the nitriding vessel to be isolated from the ammonia supply if desired.

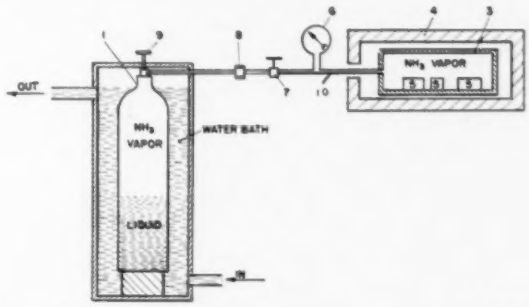


Fig. 3—Equipment set-up for supplying ammonia vapor to the nitriding vessel in the furnace. See text.

Care must be exercised to prevent overcharging the nitriding container. The simplest and safest procedure is to turn on the furnace and raise the temperature of the nitriding container to 1000° F. before closing the valve (7), and this will assure that an overcharge cannot be obtained.

The connecting tubing and fittings between the cutoff valve (7) and the nitriding reservoir (3) should be of small capacity to prevent accumulation of liquid ammonia in these fittings. The valve (7) may be located near the furnace where its temperature and that of the connecting tube between the valve and the furnace will be higher than that of the ammonia reservoir when charging the nitriding container. No condensation will then occur in the tube or valve.

We find that very satisfactory results are obtained with charging pressures ranging from 200 psi to 800 psi, and that there is little advantage in going above 800 psi unless it is necessary to obtain a very heavy case. The practical range of 200 psi to 800 psi can be obtained simply by heat-

(Continued on next page)

ing the liquid ammonia reservoir to temperatures ranging from 100° to 200° F. This is easily accomplished by means of an open water bath which also serves as a safety device to prevent serious overheating for most purposes, as the boiling point of water will give an ammonia pressure of only about 900 psi. Standard ammonia tanks are not designed to withstand pressure up to 900 psi; and, therefore, a special ammonia reservoir should be provided for use with the water bath. This vessel should be only about half filled with liquid ammonia at room temperature to provide ample space for the liquid at the boiling point of water.

When introducing ammonia in a liquid state, as shown in Fig. 1, it is necessary to have information regarding the pressure obtained at the nitriding temperature with a given vapor density, or specific volume, of superheated vapor at the nitriding temperature. Fig. 4 shows the relation between density and pressure of superheated ammonia vapor for densities ranging from zero to 0.7 lbs. per cubic foot. This curve was obtained by the extrapolation of published data on the thermodynamic properties of ammonia [5] [6] which are limited to a temperature of approximately 400° F. The actual pressures obtained will be somewhat higher because of increasing dissociation of ammonia at higher temperatures. The reaction of equations (A) and (B) indicate that the pressures shown in Fig. 4 could reach values twice as great as those shown if the ammonia dissociated completely into N_2 and H_2 inasmuch as there are twice as many gas molecules after complete dissociation. However, even with complete dissociation, the pressure could double only if there were no combination of nitrogen with the steel to be nitrided and no loss of hydrogen by diffusion. In practice, we have not observed pressure increases more than 11% above the values shown in Fig. 4.

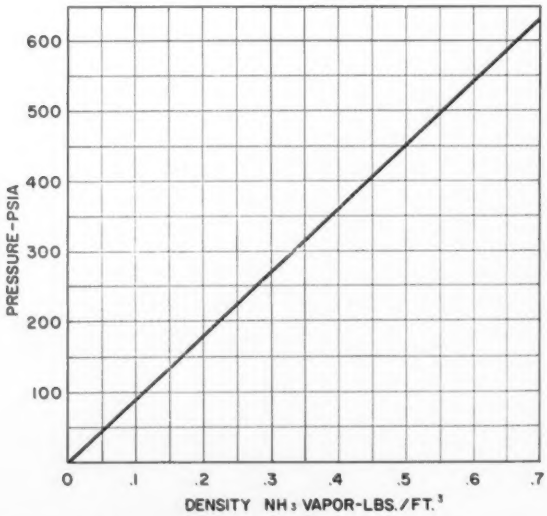


Fig. 4—The relationship of ammonia pressure to density at temperatures up to 400°F.

The nitriding results reported in this paper were obtained with two commercial types of nitriding steels. These will be referred to as Type N for the 3½% nickel grade and Type 135 for the non-nickel, low carbon analysis. Table 1 shows results of our analysis of these materials.

Table 1—Analyses of steels used in tests.

Element	N	135
Carbon	.24	.36
Manganese	.56	.46
Phosphorus	.013	.007
Sulphur	.008	.013
Silicon	.29	.18
Nickel	3.31	None
Chromium	1.23	1.45
Molybdenum	.26	.37
Aluminum	1.54	1.26

Effect of Pressure Variation

In order to determine the effect of pressure variation, a systematic series of tests was made with normalized Type N and normalized Type 135. Fig. 5 shows the results obtained with Type N, while those obtained with Type 135 are shown in Fig. 6. Referring to Fig. 5, it is seen that there is a considerable increase in the rate of nitriding, as well as in maximum hardness obtained, when the ammonia vapor pressure is increased from 100 psi to 200 psi. Advantages of high pressures are less marked as pressures are further increased from 200 psi to 2000 psi.

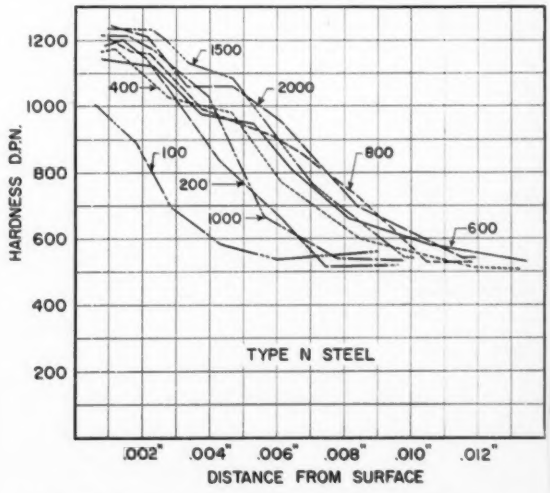


Fig. 5—Effect of pressure on case depth of Type N steel.

Fig. 6 shows results of nitriding Type 135 steel for fifteen hours at 1000° F. with pressures varying from 100 to 2000 psi. These tests show the same trend as obtained with Type N. However, in this case the lowest pressure of 100 psi gave a maximum hardness very close to that obtained at the higher pressures, and there was not such a pronounced

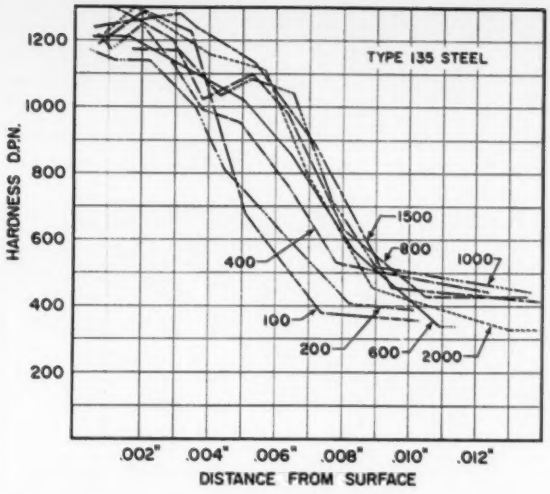


Fig. 6—Effect of pressure on case depth of Type 135 steel.

difference in case thickness between this test and those made at higher pressures. Total case depths were around .009" to .010" for pressures of 400 psi and greater.

The Bergsman Microhardness Tester is especially adapted to making hardness traverses across thin cases but the Vickers Diamond Pyramid Hardness Scale, utilized with this type of test, is probably less well known than other scales such as Brinell and Rockwell. Table II shows an approximate hardness conversion table published by ASTM which gives an indication of the hardness obtained in curves shown in Figures 5 and 6. Maximum hardness values as high as 1300 Vickers were obtained with some of the samples of Type 135 nitriding steel when nitrided by this process, and maximum hardness values around 1200 Vickers are commonly obtained at the pressures considered.

Effect of Temperature Variation

Samples of normalized Type N nitriding steel were nitrided at 800, 900, and 1000° F. for fifteen hours, using 10 grams NH_3 per square foot of surface to be nitrided in a volume giving a pressure of approximately 800 psi at 1000° F.

The hardness values determined on these specimens are shown in Fig. 7, along with those from runs at 1000° F. for 45 hours (approximately 400 psi at the nitriding temperature) and 1200° F. for 40 hours (approximately 450 psi) each having only 5 grams NH_3 per square foot of surface.

These results seem to parallel those of many investigators who worked with the conventional process and show that as the temperature drops much below 1000° F., the rate of penetration becomes too slow for commercial use; and while increasing the temperature greatly accelerates the penetration, there is a marked falling off in case hardness.

Table II—Approximate Hardness Conversion Numbers for Steel.

Brinell 3000 Kg. Load	Rockwell C—Scale	Vickers Diamond Pyramid	Shore Scleroscope
...	68	940	97
...	67	900	95
745	65.3	840	91
682	61.7	737	84
653	60.0	697	81
627	58.7	667	79
601	57.3	640	77
578	56.0	615	75
555	54.7	591	73
534	53.5	569	71
514	52.1	547	70
495	51.0	528	68

Effect of Time

A study was made to determine the rate of case formation when nitriding under pressure by the method illustrated in Fig. 1. With short pieces of steel tubing of Type N analysis to contain the specimens to be examined and using 10 grams NH_3 per square foot at a pressure of approximately 800 psi when first heated to 1000° F., a series of runs were made at 4, 15, 45, 60 and 90 hours at temperature.

The physical properties of the resulting case obtained on Type N and Type 135 both in the "normalized" and "quenched and tempered" conditions, are illustrated in Table III. (See page 36).

These results indicate considerable increase in case depth at the end of four hours over that obtained by conventional nitriding (1), with a gradual decrease in rate at longer times until, at 45 hours, both methods are about equal. Beyond 45 hours, the rate of increase of case thickness falls off considerably but the portion of case above 700 DPN increases percentage-wise along with a decrease in the "white layer." The white layer measurements are definitely less than published figures for conventional nitriding (1) in all determinations.

(*Continued on page* 36)

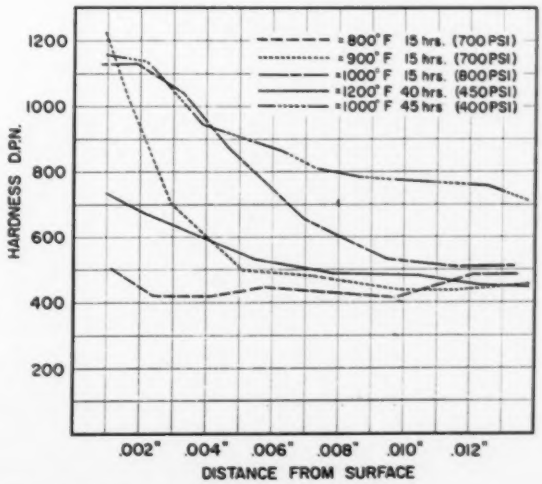


Fig. 7—Effect of various treatments on Type N steel.

Gear Teeth in Welded Segments

INDUCTION HARDENED AND TEMPERED

By **H. J. BOLL**
American Machine & Foundry Company
Brooklyn, N. Y.

The hardening of gear teeth in large segments, by induction, one tooth at a time, is being done in many shops daily.

Generally, minimum hardness required is R_c 50, and obtaining it presents no particular problem. Teeth can be brought up to full hardness by induction and then tempered, as required, by placing the entire work piece in a furnace at 350° to 450°F. for one to three hours. This low tempering temperature will not distort the piece.

A change in these requirements was encountered recently by the American Machine and Foundry Co. in their Brooklyn plant. They were called upon to harden the teeth in a gear segment having a 25 inch pitch radius, 58 teeth, 4 pitch and 2-½ inch width of tooth face. The material was C-1040 steel and the hardness required was R_c 30-35. The segment was in the form of a weldment.

Under these conditions, it was impractical to temper the entire segment in a furnace. The tempering temperature of 900° F, which is required to obtain R_c 30-35 in C-1040 steel, would have distorted the part excessively. In this connection it must be noted that one of the specifications stated that the distance between any seventeen teeth (measured over pins) must be uniform within plus or minus .001.

Preliminary tests were made by heating teeth individually for approximately 15 seconds and spray quenching with water, to harden. Then, without moving the work from the heating coil, a second power impulse was applied for about 5 seconds, in an attempt to temper. This resulted in an erratic hardness pattern. Many variations of time were tried but each resulted in too great a reduction of hardness below the pitch line.

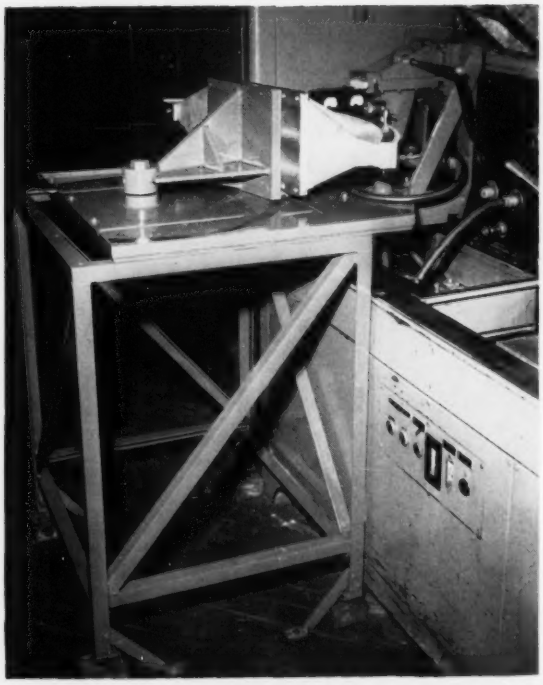


Fig. 1—Overall view of the induction hardening and tempering equipment showing work stand, induction coil and generator unit in background.

It was decided to back the coil away from the tooth 1/16" for the tempering operation and to apply several short power impulses, thus allowing the heat to spread evenly throughout the tooth. This solved the problem.

It is well to mention, at this point, that this was a "job shop" type of operation, wherein the particular job had to be set up and dismantled about every ten days. This was taken into account in the design of the fixture. As seen in Fig. 1 it consists of an angle iron stand, on top of which is mounted a work pivoting bracket and the induction heating coil.

In hardening one tooth at a time, it is necessary to bring each tooth accurately into radial registration with the heating coil. The tooth can then be moved laterally into the coil or the coil can be moved to surround the tooth. In this case, since the work piece weighed nearly 400 pounds, it was found more practical to move the coil to the work.

In operation, the work is bolted to a pivoting bracket, about which the work turns freely. As illustrated in Fig. 2, proper tooth registration is accomplished by inserting two removable pins into tooth spaces on either side of the heating station. These pins make contact with microswitches beneath the table; which in turn complete the electrical circuit that provides power to the induction generator. By this device, it is impossible to turn the heat on unless a tooth is in proper registration with the coil.

Fig. 3 shows the equipment without a work piece in place. The coil is mounted on a movable carriage, manually operated through rack and pinion. On this carriage are also mounted two perforated brass tubes through which the quenching water is sprayed. The travel of the carriage toward the work is limited by a two-step stop, shown in the photograph directly above the coil. With this stop swung to the left, the coil can move forward to the hardening position. Swinging the stop to the right, limits the forward motion, so that the coil stands 1/16" farther from the tooth. As previously explained, this is necessary for tempering.

The two-turn coil is made of 1/8" O.D. copper tubing. The coil ends are fitted into rectangular copper shoes which are spring loaded to ride on two silver clad copper electrodes or bus bars, which are connected to the induction generator. This provides a sliding contact between coil and generator, which is required in moving the coil into and out of engagement with the respective gear teeth. Without the silver cladding, a copper to copper contact would soon pit and gall. The coil, coil shoes and bus bars are all water cooled.

Fig. 2—Close-up showing method of registering teeth with removable pins. Power circuit for generator cannot be closed without pins in place.

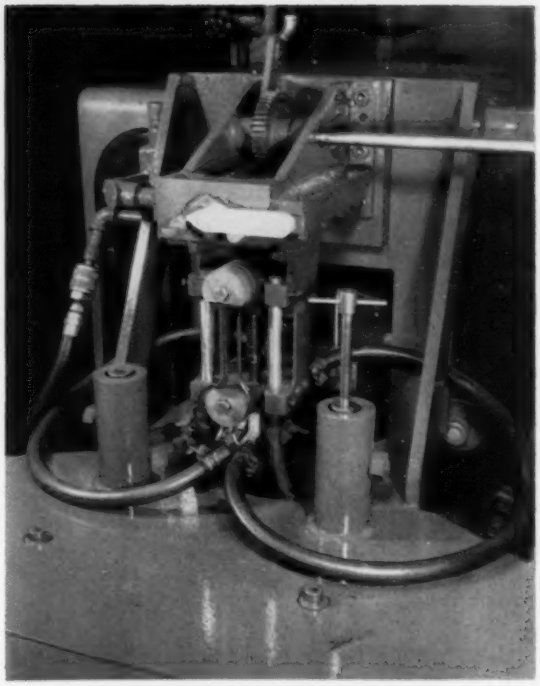


Fig. 3—A view of the coil arrangement with work piece removed. See text for details of construction.

The generator control panel is equipped with timers to provide variable automatic cycles for heat and quench.

The cycle of operations is as follows:

1. Locate gear tooth by inserting two pins in tooth spaces.
2. Move coil forward, to surround gear tooth (swing-stop in left hand position).
3. Press button on work table to apply heating current (timer pre-heat for 15 seconds).
4. When current "clicks" off, move carriage back. Pre-set timer turns quenching water on automatically. Moving the coil out of the tooth space while quenching insures full flow of water to all tooth surfaces without coil interference.

The quench water is permitted to run long enough to remove most of the heat from the work piece. Unless this is done, in quenching each tooth, the work piece will become progressively hotter until distortion takes place. In addition the hardness pattern of the last teeth will not be identical to that produced in the first few teeth, when the part was still cold.

5. Move swing-stop to the right for tempering.

(*Continued on page* 14)

Heat Treatment in the

PRODUCTION OF MAGNETS

Proper heat treating produces the most powerful magnets commercially known today—high-cobalt "directionalized" Alnicos.

In the past, heat treating of magnets was a critical job-shop operation. But in the Edmore, Mich., plant of Carboloy Department of General Electric Company, the operation has been converted to practically a production-line operation, without sacrificing delicate control.

Two basic heat treating processes, "directionalizing" and "aging" are employed to provide the vital end characteristics, permanency and magnetic strength, of these cast magnet alloys. All Alnico magnets are heated above their Curie temperature around 900°C. (1652°F.) then cooled to produce their best magnetic properties. Alnico is usually classified as a precipitation or dispersion hardening type alloy. The best permanent magnet properties of these alloys depend on a transitional metallurgical condition, with a new metallurgical phase in the initial stage of formation but still coherent to some extent with the high temperature matrix phase. Such transitional structures have high magneto-crystalline anisotropy, which means that their magnetic properties are direction-sensitive. These transitional structures provide some isolation of elementary magnet components, or "domains." These factors contribute to the magnetic stability of the alloys.

In a typical magnet alloy such as Alnico 5, the desired metallurgical reaction can be influenced by a strong magnetic field. The magneto-crystalline anisotropy of the transition metallurgical structure will have a large component along the axis of the applied magnetic field. In other words, the magnets have an "axis" of preferred magnetic properties. When the magnets are magnetized along this axis, they exhibit superior magnetic properties.

This transitional state is usually produced by heating in one of three types of furnaces, then cooling in a magnetic field.

Rough ground magnets are heated in one of these 3 types of furnaces:

1. Roller hearth—the new plant employs the only one in the industry. It has five times the capacity of the other heating equipment—see Figs. 1 and 2.

2. Box-type resistance furnaces—two are single door, 12 inch x 36 inch hearth models, rated at

Fig. 1—The new roller hearth furnace above is the only one in the magnet manufacturing field. Ring magnets being loaded above travel 21 feet through the furnace on conveyor rolls, emerge with a temperature of about 900°C. This air atmosphere furnace uses 136 KW, has maximum temperature of 1100°C. Door opens to 24x5 inches.

Fig. 2—Exit end of automatic roller hearth heat treating furnace. Here work in "boats" or trays is being pushed into solenoids for directionalizing. Production of unit is over 500 pounds per hour.

30 and 37 KVA respectively. Five 18 inch x 72 inch hearth furnaces have doors at each end, and require 25 KVA. Three of these contain molybdenum heating units and hydrogen atmospheres, permitting temperatures above 1300°C. (2372°F.). Other box types are limited to 1000°C. (1832°F.).

3. Induction furnace—one is used here, as shown in Fig. 3, mostly for thin-walled ring magnets.

The roller hearth heating cycle begins with the alignment of magnets in an 18 x 30 inch pallet tray. This tray moves through the furnace on conveyor rolls. As it nears the discharge end a signal light alerts the operator, who then places the pallets in solenoids to cool. As with magnets from the box furnaces, care is taken to position the tray or "boat" so that its magnets are properly oriented with respect to the coil's field.

Before directionalizing a typical Alnico formerly required a solution treatment at 1300° C., for 1½ hours to assume a single phase metallurgical structure prior to cooling. At Carboloy, zirconium is added to slow down the rate of formation of the precipitate and eliminate the necessity for the 1300° C. heat treatment.

Fig. 3 — Ring magnets on quartz rod have been heated by induction furnace in background. Operator is placing them in directionalizing coil for cooling. Magnets are pushed through the 9-foot coil on the angle iron, and emerge at the opposite end ready for aging.

Most directionalizing cooling equipment consists of solenoids cooled with water jackets. The magnetic flux lines here are parallel to the coil's axis. Special directionalizing fixtures are required for odd-shaped magnets.

Field strength depends on current and number of turns in the coil. The regular coils, with many wire turns, operate on direct current at line values. Special fixtures, with only a few turns of copper tubing, need a direct current several hundred times greater for the same field strength. Fifteen copper oxide rectifiers located above the heat treat area each supply 2000 amps at 6 volts. The fixtures usually require 6000 amps each, but 30,000 amps is available for each.

Fig. 4—Three of the six aging or draw furnaces are shown here. Following heat treatment to about 900°C, magnets in metal baskets are placed in a barrel-like container, left, which is then lowered into one of the aging units for 5 hours.

Aging, final step in magnet heat treatment, is applied to all cast magnets at Edmore, whether or not they require previous directionalizing. Aging consists of holding the magnets for five hours at 600° C. (1112° F.). This causes growth of any p ecipitate particles or nuclei formed in the previous heat treatment. This treatment refines the metallurgical structure to a condition of maximum magnetic properties.

Aging equipment seen in Fig. 4 includes five 60 KW and one 45 KW air draw furnaces. These are cylinders about four feet in diameter and seven feet high, set in the floor to one-half their height for convenient loading from the top. Each holds a tub 25 inches in diameter and 3 feet high. The tub contains six baskets, with a total magnet load of 700 pounds.

The furnaces have recirculating fans, and are heated by resistance elements in the walls. For a five-hour cycle, total output of the six furnaces is 800 pounds per hour. ■ ■ ■

William Adam Jr. President of Ajax

At the annual meeting of Ajax Electric Company, Mr. William Adam, Jr. was elected President after Dr. G. H. Clamer announced his desire to retire from that office. John E. Haig and Leon B. Rosseau were elected Vice Presidents.

Dr. Clamer will continue as President of Ajax Electro Metallurgical Corporation, Ajax Electrothermic Corporation and Ajax Engineering Corporation.

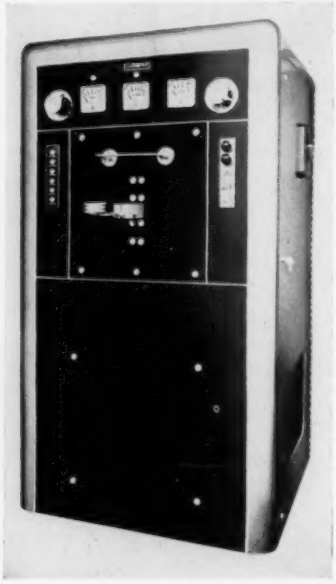
5 KW Induction Unit

A redesigned 5 KW output high frequency induction heating unit (Model LI-5A-1) is offered by Lindberg Engineering Company, 2450 W. Hubbard St., Chicago, Ill., for soldering, brazing and light heat treating applications.

The basic redesign incorporates a heavier sheet steel cabinet for industrial use insuring minimum R.F. radiation and fully complies with FCC regulations. Interior steel partitions are provided to isolate oscillator, power and control components which are accessible for inspection through large access doors.

Lindberg's "Checklite" system of indicating lamps have been relocated to the cabinet front for easier observation and convenience. These externally located lamps instantaneously reveal any abnormal operating conditions at any of the many protective devices.

The temperature controlled water cooling system has been redesigned to reduce water consumption and to eliminate any possibility of moisture condensation on internal components and work coils. The non-ferrous cooling system incorporates molded porcelain water coils to form insulating water columns eliminating rubber or organic type hose.



An electrical interlock system prevents the application of power when cooling water is not flowing eliminating the danger of work coil burnouts.

Industrial type tubes are provided with constant voltage transformers to maintain proper tube filament voltage values regardless of line voltage fluctuations.

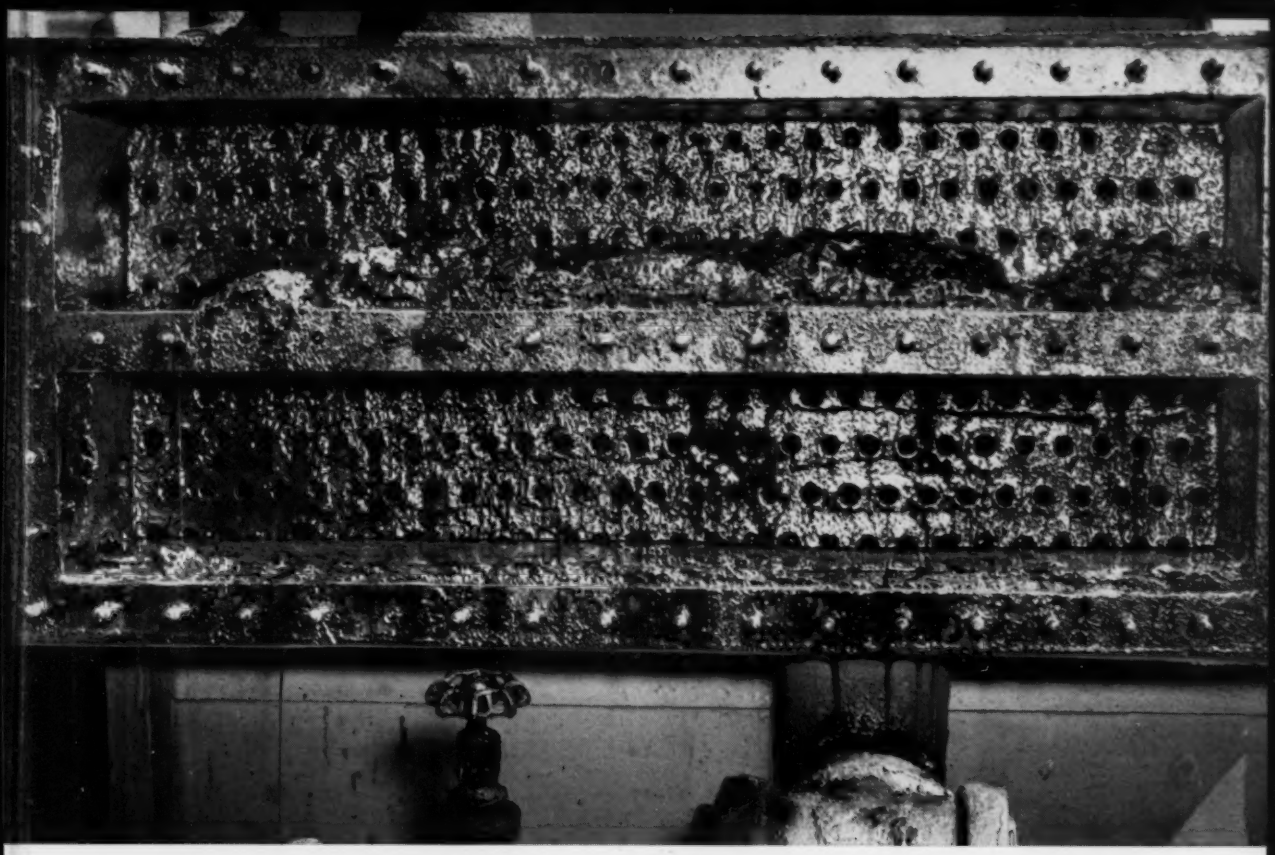
The tank capacitor is hermetically sealed against dust and dirt requiring no servicing or refilling.

All operational controls are accessible from the outside of the unit.

Metal Cleaning Concentrate

A ferrous metal washing compound for removal of quenching oils after heat treating has been announced by Ipsen Industries, Inc. of Rockford, Illinois. Suitable for both batch and spray type washers, the degreasing agent will reportedly produce clean work pieces within 3 to 10 minutes in circulating-type washing equipment. The degreasing agent is a fine, granular mixture of alkaline materials combining detergents and surfactants. Labeled Compound 103, it is said to elimi-

(Continued on page 12)



If you use an ordinary quenching oil that forms sludge deposits, here's what can happen to your oil cooler.

SUN QUENCHING OIL LIGHT WON'T CLOG COOLERS

Sludge lowers operating efficiency, ups maintenance costs, cuts output. Sun Quenching Oil Light, when used at normal temperatures, keeps coolers clean, because it has a natural detergent action that prevents the formation of sludge deposits and aids in removing any deposits that have accumulated. And this oil thins out when heated—reduces drag-out, brings operating costs down. The booklet "Sun Quenching Oils" tells the story of Sun's money-saving quenching oils. Call a Sun office or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. MR-3.

INDUSTRIAL PRODUCTS DEPARTMENT

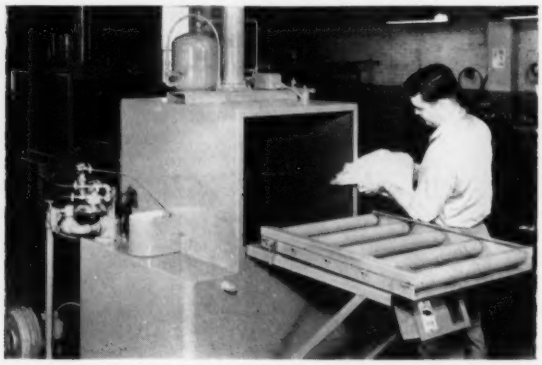
SUN OIL COMPANY

SUNOCO®

PHILADELPHIA 3, PA. • SUN OIL COMPANY LTD., TORONTO & MONTREAL

News to Heat Treaters (cont'd)

nate the need for secondary washing operation. Use of Compound 103 with new Ipsen automatic washer units, which were recently announced, requires a total cycle of five to seven minutes for thorough metal washing. Solution temperatures,



work handling, and cycles for solution circulation and skim-off are all controlled automatically by pre-settings on a panel conveniently located on the front of the washer. Because of work handling efficiency and washing speed, the units are especially adapted to line operation as well as a wide variety of standard degreasing and oil removal applications.

Automatic Wet-Blaster

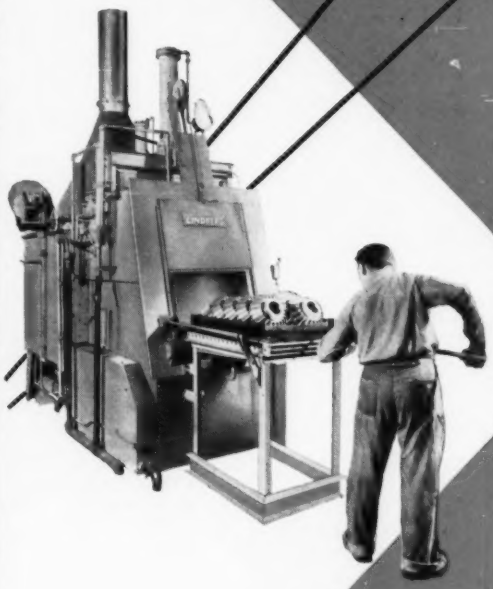
The addition of a new automatic model to its line of standard, manually-operated units has been announced by The Cro-Plate Co., Inc., 747 Windsor Street, Hartford, Connecticut, manufacturers of pressure blast wet-blasting equipment.

Known as the pressure blast Roto-Matic, this new wet-blasting equipment was designed for the elimination of hand filing, grinding, wire brushing and chemical cleaning of small metal parts. In

(Continued on page 14)

5 FURNACES IN ONE

the *LINDBERG* Carbonitriding Furnace



Yes, it's many furnaces in one! It's designed not only for carbonitriding . . but also for hardening, carburizing and carbon restoration. It's self contained . . it's easy to maintain!

10 reasons why Lindberg Carbonitriding Furnaces are better:

1. Heating is by new type, gas-fired, vertical radiant tubes. They weigh only 29 pounds each . . can be changed in two minutes. Just lift out the old one, and lower the new one in its place.
2. Vertical radiant tubes last longer . . often two or three times as long.
3. Quench tank is built-in . . no costly excavation or piping necessary. Distortion is minimized because quenching takes place within furnace structure, and heated work is never exposed to outside air.
4. Quench tank has fin type oil cooler . . maintains oil at proper temperature for quenching.
5. Specially designed purge chamber purges work loads before they enter heating chamber.
6. Special check-light system tells you where charge is at any given time.
7. Control of heating and quenching cycle is automatic. Uniform case depth is assured because each charge remains at heat same length of time.
8. Depending on your production requirements, Lindberg Carbonitriding Furnaces are made for automatic, semi-automatic, or manual charging.
9. You're not experimenting with Lindberg Carbonitriding Furnaces. They've been tested . . under three years of rough operating conditions.
10. The famous Lindberg "Hyen" generators which supply atmosphere for Lindberg Carbonitriding Furnaces are instantly adjustable for many different types of atmospheres.

For full details, ask for bulletin §241.

LINDBERG FURNACES

News to Heat Treaters (cont'd)

operation, the operator is seated at the front of the unit and loads and unloads work-pieces from the rotating table which incorporates appropriate work holding fixtures. The cabinet interior is divided into three chambers accessible from all sides by means of inspection doors; the blast chamber where fixed position guns finish the work in part or entirely; the rinse chamber where abrasive slurry is rinsed from the work; the air-dry chamber where the work pieces are dried.

Made of stainless steel throughout, no pumps or mechanisms of any kind are employed in the blast system. Two blast circuits are available, either regular velocity which works on the aspiration or suction principle and high velocity which operates on the pressure tank system, a patented feature.

Safety feature is added to Pyrometer Controllers

An additional safety monitoring feature has been incorporated in the design of a new millivolt-type pyrometer control instrument made by the Minneapolis-Honeywell Regulator Company, to offer industrial process operators added protection for their systems, the firm's Industrial Division in Philadelphia recently announced.

The improved instrument, known as a "Protect-O-Vane" controller, was designed as an auxiliary controller to shut down a process not only when there is an excess temperature condition but also in the event of instrument component or power failure.

The added cut-off feature can be incorporated into existing controllers by replacing the plug-in unit.

(*Continued on page* 16)

Gear Teeth in Welded Segments Induction Hardened and Tempered (cont'd)

6. Move carriage forward to stop.

7. Press button to apply tempering heat. A special timer hook-up automatically provides six heat impulses of two seconds "on" and five seconds "off."

8. Move carriage back. Automatic quench is applied simultaneously to cool off the tempered tooth.

9. Remove registering pins, rotate gear to next tooth, re-insert pins and proceed with hardening of next tooth.

The complete operation, floor to floor, takes about 3-½ hours. Many tests were made, by actually cutting gears apart, to demonstrate that the hardness pattern is uniform across the entire tooth face. The hardness extends well below the pitch line and is definitely within the hardness limits specified. ■ ■ ■

THE NAME THAT STANDS OUT IN BLACK OXIDE FINISHES

Type A Blackening Process For Steel

Improves Your Product
Increases Production
Cuts Costs

TROUBLE-FREE • ECONOMICAL • ATTRACTIVE

- One Bath -- One Salt
- Lower Operating Temperature
- Self Rectifying
- Faster Blackening Cycle
- More Corrosion Resistant

Also Black Magic Blackening Processes for other ferrous and non-ferrous metals; metal cleaners, rustproofing oils and waxes, plating specialties and a complete line of heat treating salts.

Mitchell-Bradford

THE MITCHELL-BRADFORD CHEMICAL CO.

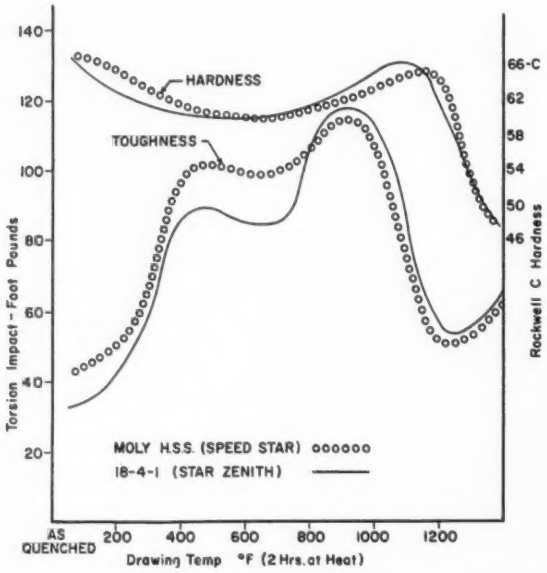
2445 Main St. Stratford, Conn.

QUALITY PRODUCTS OF CHEMICAL RESEARCH

HEAT TREATING HINTS

Effect Of Drawing Temperatures On Torsion Impact Toughness Of High Speed Steels

Tools made of high speed steels whose primary functions are such that toughness is of more importance than cutting qualities may be tempered at lower temperatures to enhance their toughness characteristics. Standard 18-4-1 and moly high speeds steel exhibit almost the same properties when heat treated as shown in the chart below. It is quite evident that maximum thoughness for both is obtained by tempering between 800°—900° F.



At these tempering temperatures the corresponding hardness may vary from 61 to 63 Rc which for special impact applications is sufficiently hard for comparatively good cutting properties.

CARPENTER SERVICE BULLETIN
Vol. 3, No. 13
The Carpenter Steel Co.
Reading, Pa.

Nitriding High Carbon, High Chrome Steels

High carbon, high chrome steels that exhibit a secondary hardness after tempering at approximately 900° to 1000° F. may be nitrided to obtain high surface hardness for extreme abrasive wear. The nitriding may be performed by using gaseous ammonia or, for very shallow cases, a salt bath.

The nominal composition of such a salt would be NaCN—55 to 65%, KCN—35 to 45% and may be obtained from any of the various manufacturers who regularly supply heat treating salts.

In a particular instance a punch for blanking retaining rings used by the Industrial Retaining Ring Co. of Mount Vernon, N. Y. was nitrided in a salt bath. After heat treatment and double tempering at 925° F. the high carbon, high chrome punch was nitrided at 925° F. for 45 minutes.

This treatment more than doubled the amount of blanks obtained between grinding operations.

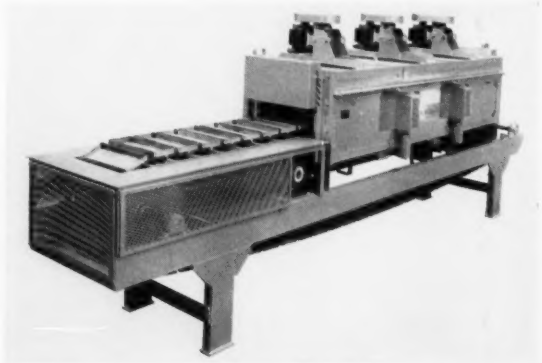
The very shallow case produced by this method has a high hardness but due to its thin depth does not exhibit the brittleness of a heavier case which might chip or spall under the impact of the blanking operation.

FRED HEINZELMAN, JR.
Fred Heinzelman & Sons
New York, N.Y.

News to Heat Treaters (cont'd)

Versatile Conveyor Furnace

This conveyor furnace, ordered by a large manufacturer of jet engine parts for heating aluminum and brass billets prior to forging, was designed for a specific job, but achieved versatility through the incorporation of many additional features. These features made it possible for the furnace to be used



to temper, anneal, stress relieve, or do other heating operations requiring a temperature up to 1650° F. Elements are of nickel chromium wire wound through ceramic refractories. Three fans are used for effective circulation in the heating chamber. Therefore, this smaller, more economical furnace is able to do the job. A variable speed drive mechanism adjusts the conveyor speed so that parts can be held in the furnace chamber from 13 minutes to over 2 hours.

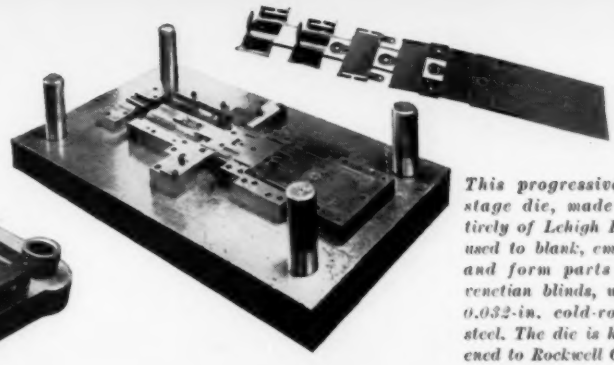
(Continued on page 18)

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

Door knobs are blanked and drawn from 0.035-in. steel or brass on this Lehigh H progressive die. Before Lehigh H was used, the die was redressed almost daily. Now, in addition to providing a better surface on the knobs, the die requires redressing only every sixth week.



This progressive 7-stage die, made entirely of Lehigh H, is used to blank, emboss and form parts for venetian blinds, using 0.032-in. cold-rolled steel. The die is hardened to Rockwell C-61.

THREE HIGH-PRODUCTION DIES MADE OF LEHIGH H

Lehigh H is a high-carbon, high-chromium tool steel with characteristics that make it ideal for high-production dies for long-run jobs. Here are the reasons why toolmakers have used it over so many years, with excellent results:

1. Maximum Wear Resistance. Because of its high carbon-chromium content, Lehigh H puts up good resistance to wear. It is the most economical steel for long runs.

2. Close Tolerances. Lehigh H is an air-hardening steel, with only minimum distortion during heat-treatment.

3. Safe Hardening. It is cooled in still air from a hardening temperature of 1850 F, and minimizes the cracking hazards of intricate dies, thin sections, and insufficient radii.

4. Severe Service. Lehigh H is a deep-hardening steel, even in large sections, and has high compressive strength.

When three die rings were needed for high-production blanking of covers for large drums for shipping carbide, the manufacturer specified that each ring be held to close tolerances, and after hardening have a Rockwell-C hardness of 61 to 63. The rings were made from Lehigh H. Each was given a C-scale Rockwell test at four points, with these results: Ring 1: 61, 62, 61, 61; Ring 2: 62, 62, 63, 62; Ring 3: 62, 62, 61, 61.

Peeling Off Ribbons

This chip is curling off the tread of a 33-in. railroad car wheel. The tire-forming tool, nearly hidden at the left, is made of Bethlehem 66 High-Speed Steel, and is used for both roughing and finishing. On untreated wheels these tools average about 45 wheels before regrinding is necessary; on heat-treated wheels, they average 16 per grind.

66HS is ideal for a wide variety of cutting tools. It's our M2 grade, containing 6 pct tungsten, 5 pct molybdenum, 4 pct chromium and 2 pct vanadium.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Improper Tool Clearance Reduces Tool Life

In operations such as punching and blanking, the service life of the tool is largely dependent upon the tool clearance. For example, many punch-and-die sets are made up with a "standard" clearance. But as the proper clearance for punching soft steel is approximately one-tenth of the stock thickness, it is evident that the "standard" clearances are correct for only one stock thickness.

The ideal tool clearance produces flat, sharp punchings with minimum tool load. Excessive clearance produces deformed and burred punchings, and requires high tool loads which shorten tool life. Though insufficient clearance produces flat, sharp punchings, it also requires excessive tool load, and should therefore be avoided. Besides, it increases the danger of damaging the tools because of misalignment.

News to Heat Treaters (cont'd)

New Room-Temperature Metal Cleaner

A new metal surface cleaner that can be used at room temperatures has been developed in the research laboratory of Klem Chemicals, Inc., 14401 Lanson, Dearborn, Michigan.

The new cleaner is identified as Klem K-A-T Cleaner. It is a combination of a special alkaline and an efficacious emulsion cleaner and can be used for removing soil from both ferrous and nonferrous metals.

Principal advantage of Klem K-A-T Cleaner is that it eliminates the need for heat coils in the tank and the cost of heat. For this reason, it is particularly adapted to the smaller shop or department where cleaning is not a regular production process, or where heat might have a physical effect on the part being cleaned.

New Hardness Tester

A precision hardness tester is being marketed by the George Scherr Co., Inc., New York 12, N.Y. It is a portable bench type instrument shown in the illustration which is an exclusive design combining a positive controlled diamond penetrating action with a microscope of 400 magnifications. The microscope is swung directly over the impression to read the hardness by measuring with a reticule scale and vernier in .0005 millimeter resulting in hardness readings of unusual precision in half a micron (.0005 millimeter).

Instructions and tables are furnished with the instrument converting readings into Rockwell and other standard hardness scales in use.

Also coarse impressions such as Brinnel ball test may be measured for which purpose a coordinate measuring stage is provided such as found on toolmakers microscopes, thus making the tool more useful for general optical measuring.

An Incoloy rack is being loaded with cold-rolled steel bell cranks for eight minutes heat treating in a 1575° cyanide salt bath.

How Incoloy racks cut replacement costs 90% in 1575°F. cyanide salt bath

Cold-rolled steel parts for Underwood typewriters have to be in perfect alignment in order to function properly. And they are heat treated in a 1575° — 60% cyanide salt bath for eight minutes to give them extra strength and wear-resistance.

That's where Underwood Corporation used to have trouble.

At first the parts were heat treated in mesh baskets — but the time required to straighten out-of-line parts forced this method to be abandoned.

Then the engineers tried perforated racks — they worked fine but their service life was only about three weeks.

Finally an Inco Nickel Alloy — high-temperature- and corrosion-resisting Incoloy® — was tried.

Now after more than ten months in service the Incoloy racks are still taking the treatment!

This not only made a substantial saving for Underwood in replacement costs, but it also made a considerable saving on assembly time for straightening out-of-line parts.

Incoloy, companion alloy to Inconel®, has unusual resistance to many types of corrosion encountered in heat treating processes. It has good strength at temperatures up to 1850° F. And it is readily welded and fabricated.

For more information on this recent member of the Inco family, write for your copy of "Progress Report on Incoloy." And if you have a special heat treating problem, write Inco's Technical Service Section for help.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK

Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • INCONEL® • INCONEL "X"®
INCONEL "W"® • INCOLOY® • NIMONIC® Alloys
NICKEL • LOW CARBON NICKEL • DURANICKEL®

DO YOU KNOW WHAT HEAT T

If you now do your own heat treating — or are contemplating the installation of a heat treating department — have you carefully considered all of the costs involved? Each of the following factors must be given careful consideration:

LABOR

Trained operators require years of experience, without them you cannot expect satisfactory heat treating. Can you afford men of this caliber for the amount of heat treating you require?

PLANT SPACE

Does your present department have enough space to work efficiently? If planning a new department, will it require an addition to your plant?

MAINTENANCE

Equipment must be kept in constant repair to prevent rapid deterioration. What does it cost you or what will it cost you?

INSURANCE

What has the installation of heat treating department done to your insurance rates? What can you expect if you are planning a new department?

EQUIPMENT

Can you economically install sufficient equipment to handle all of your requirements for hardening, annealing, carburizing, nitriding, etc., or can your present equipment handle all these operations with successful results? Is your capacity flexible enough to handle peak loads?

SUPPLIES

Gas, electricity, chemicals—an endless variety of materials are needed continually. Are you wasting money due to insufficient work to keep all equipment going? Closing down and re-heating furnaces is an expensive waste.

TESTING EQUIPMENT

A constant check on heat treating operations and results is required to maintain quality and uniformity. Add this to the cost of your equipment along with skilled operators.

These are the major items to be figured into the cost of your own heat treating department—there are others which arise in special cases.

The problems listed here have been faced and overcome by commercial heat treaters. They know the answers because heat treating is their business —just as the manufacture of your products consists of solving numerous problems in your business.

If you are faced with heat treating problems or the need for heat treating services write

METAL

271

EATING COSTS ?

When You Do Your Own

For the BEST in Heat Treating Consult these Companies:

ALABAMA

Southern Metal Treating Co., Inc.
3131 10th Ave., North, Birmingham 4

CALIFORNIA

Hollywood Heat Treating Co.
1046 No. Orange Drive, Los Angeles 38
Lindberg Steel Treating Co.
2910 S. Sunol Drive, Los Angeles 23
Cook Induction Heating Co.
4925 East Slauson Ave., Maywood
Dexter Metal Treating Co.
1026—77th Ave., Oakland 21
Industrial Steel Treating Co.
1549—32nd St., Oakland 8
Valley Metal Treating Co.
355 So. East End Ave.

COLORADO

Metal Treating & Research Co.
4110 Fox St., Denver 16

CONNECTICUT

Commercial Metal Treating, Inc.
89 Island Brook Ave., Bridgeport 6
Stanley P. Rockwell Co.
296 Homestead Ave., Hartford 5

ILLINOIS

Seneeca Heat Treating Co.
70 S. Batavia Ave., Batavia
Accurate Steel Treating Co.
2226 W. Hubbard St., Chicago 12
Chicago Steel Treating Co.
333 North California, Chicago
Dura-Hard Steel Treating Co.
2333 West Deming Place, Chicago 47
Pearson Industrial Steel Treating
5757 Ogden Ave., Chicago 50
Perfection Tool & Metal Heat Treating Co.
1740 West Hubbard St., Chicago 22
Fred A. Snow Co.
1942 West Kenzie St., Chicago 22
American Steel Treating Co.
P. O. Box A, Crystal Lake
Eklund Metal Treating, Inc.
721 Beacon St., Love Park
Lindberg Steel Treating Co.
1975 No. Ruby St., Melrose Park
O. T. Muehlemeyer Heat Treating Co.
1531 Preston St., Rockford
C. U. Scott & Son, Inc.
1510 First Ave., Rock Island

INDIANA

Nerl Heat Treat Corp.
1824 So. Franklin St., South Bend 23

MARYLAND

Maryland Tool Company
111-13 Hollingsworth St., Baltimore 2

MASSACHUSETTS

New England Metallurgical Corp.
9 Alger St., South Boston 27
Porter Forge & Furnace, Inc.
74 Foley St., Somerville 43
Greenman Steel Treating Co.
284 Grove St., Worcester 5

MICHIGAN

Acme Steel Treating Co.
119 Lieb St., Detroit 7
Anderson Steel Treating Co.
1337 Maple St., Detroit 7
Bosworth Steel Treating Co.
18174 West Chicago Blvd., Detroit 28
Commercial Steel Treating Corp.
6100 Tireman Ave., Detroit 4
Commonwealth Industries, Inc.
5922 Commonwealth Ave., Detroit 8
Michigan Steel Processing Co.
3120 Denton, Detroit 11
Standard Steel Treating Co.
3468 Lovett Avenue, Detroit 10
Vincent Steel Process Co.
2424 Bellevue Ave., Detroit 7
State Heat Treat, Inc.
520 32nd Street, S. E., Grand Rapids 8
American Metal Processing Co.
12000 East Nine Mile Road, Van Dyke

MINNESOTA

Metallurgical, Inc.
900 East Hennepin, Minneapolis 14

MISSOURI

Metallurgical, Inc.
1915 Tracy Ave., Kansas City 8
Lindberg Steel Treating Co.
650 East Taylor Ave., St. Louis 15
Paulo Products Co.
5711 West Park Ave., St. Louis 10

NEW JERSEY

Ace Heat Treating Co.
611 Grove St., Elizabeth
American Metal Treatment Co.
Highway 25 and LaFayette St., Elizabeth
Benedict-Miller, Inc.
Marin Ave. and Orient Way, Lyndhurst
Bennett Steel Treating Co.
246 Raymond Boulevard, Newark 5
L-R Heat Treating Co.
107 Vesey St., Newark
Temperature Processing Inc.
228 River Road, North Arlington
Metro Heat Treat Corp.
9 Victoria Place, Ridgefield

NEW YORK

Fred Heinzelman & Sons
138 Spring St., New York 12
Alfred Heller Heat Treating Co., Inc.
391 Pearl St., New York 38
Metro Heat Treat Corp.
466 Broome St., New York 13
Lindberg Steel Treating Co.
620 Buffalo Road, Rochester 11
Rochester Steel Treating Works
962 Main Street, E., Rochester 5
Syracuse Heat Treating Corp.
1223 Burnet Ave., Syracuse 3

OHIO

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Wooster Pike & Mariemont Ave.,
Cincinnati 27
Queen City Steel Treating Co.
2980 Spring Grove Ave., Cincinnati 25
Ferrotherm Co.
1861 E. 65th St., Cleveland 3
Lakeside Steel Improvement Co.
5418 Lakeside Ave., Cleveland 14
George H. Porter Steel Treating Co.
1273 East 55th Street, Cleveland 3
Reliable Metallurgical Service, Inc.
3827 Lakeside Ave., Cleveland 14
Winton Heat Treating Co.
20003 West Lake Road, Cleveland 16
Dayton Forging & Heat Treating Co.
2323 East First St., Dayton 3
Ohio Heat Treating Co.
1100 East Third St., Dayton 2

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J. W. Rex Co.
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The Drever Company
220 West Cambria St., Philadelphia 33
Lorenz & Son
1351 N. Front St., Philadelphia 22
Metlab Company
1000 East Mermaid Lane, Philadelphia 18
Wiedemann Machine Co.
4272 Wissahickon Ave., Philadelphia 32
Ferrotherm Company
4911 Butler St., Pittsburgh
Pittsburgh Commercial Heat Treating Co.
49th St. and A.V.R.R., Pittsburgh 1

TEXAS

Cook Heat Treating Co., of Texas
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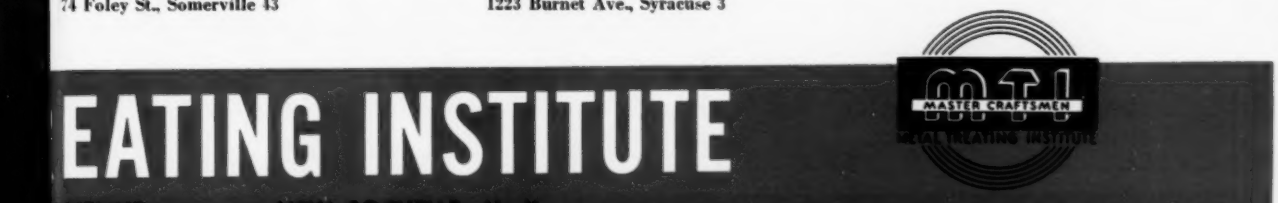
1536-40 West Pierce Street, Milwaukee 4
Metal Treating, Inc.
720 South 16th St., Milwaukee 4
Supreme Metal Treating Co.
4440 West Mitchell St., Milwaukee 14
Thurner Heat Treating Co.
809 West National Ave., Milwaukee 4
Wesley Heat Treating Co.
1333 West Pierce Street, Milwaukee 4
Wesley Steel Treating Co.
1301-1403 West Pierce St., Milwaukee
Harris Metals Treating Co.
1635 Murray Ave., Racine
Spindler Metal Processing Co.
2338 Mead Street, Racine
Wesley Metal Treating Co.
2320 Mead Street, Racine



INSTITUTE NEWS

MID-WEST CHAPTER MEETING

As was reported in the January-February issue, a Mid-west Chapter Meeting of the MTI was held in Chicago which was attended by President Cliff Cook and Secretary Herington. A trip to Chicago, of course, would not be complete without devoting a day or two to the friendly hospitality of the Milwaukee members and, naturally, advantage was taken of the opportunity.

Cook and Herington placed themselves in the capable and hospitable hands of Clarence Graham of Metal Treating, Inc. and Saturday, January 15th was devoted to tours of Clarence Graham's plant; Thurner Heat Treating Company and a quick look at Supreme Metal Treating Company.

Saturday evening the Clarence Graham's were hosts at a truly super house party where, in addition to being entertained by comedian-pianist Joe Wesley (brother of the inimitable Charles Wesley), they met a number of Milwaukee's finest.

On Monday, all forces were gathered at the plant of Wesley Steel Treating Company and there there was formed a caravan of sedans and station wagons led off by Charlie Wesley and a group, consisting of newspaper reporters, heat treaters, your President and Secretary, real estate men, politicians and, of course, Charlie Wesley's charming wife, who, by the way is President of the Allied Metal Treating Corporation of Kenosha, Wisconsin. After inspection of this new plant, whose equipment ie now being installed and with considerable plant and facility expansion already in the works,

Shown at the Valley Inn are left to right, Robert Seger, Chicago Steel Treating Co.; Cliff M. Cook, President, Metal Treating Institute and Charlie Wesley, Wesley Steel Treating Co.

the caravan rolled into Racine to "The Valley Inn" to be met by photographers and former Vice President George Harris of Harris Metal Treating Company of that City.

Charlie Wesley had arranged things in this usual efficient and grand manner with an excellent luncheon being served in a private dining room and, of course, lots of lively discussion and bantering.

After luncheon, the group went on to the plant of Spindler Metal Processing Company and Wesley Metal Treating Company in Racine and then returned to the Wesley Steel Treating plant in Milwaukee. There the Hyshek Metal Processing Company facilities were examined (they specialize in flame hardening of all kinds) after which the group broke up. The day concluded for President Cook and Secretary Herington with an excellent dinner at the Milwaukee Athletic Club with Charlie Wesley as host.

1954 SPRING MEETING UNDERWAY

As this issue goes to press the final program of the 1954 Spring Meeting being held on April 5th, 6th and 7th is being prepared for release to all members. Each morning of the three day meeting will be devoted to business and

About to enjoy dinner at the Valley Inn are, back row—James Airoldi, Airoldi Cartage Co.; Hugh Southmayd, Appraiser of Kenosha County; Robert Wilkins, the Milwaukee Journal; Charles Lepp, Lepp & Phillips, Attorneys-at-law; George Harris, Harris Metals Treating Co.; Robert Thurner, Thurner Heat Treating Co. Seated in front are, Harold Wesley, Mr. and Mrs. Charles Wesley and Mr. C. Harold Ray, Wesley Steel Treating Co.

technical sessions; afternoons are being kept open to allow all to enjoy the excellent recreational facilities of The Homestead.

One of the three mornings will be devoted to Cost Accounting and the Committee, headed by Ken Jenks, will present four papers, as follows:

"Determination of Expenses," by Fred Rimmele, Benedict-Miller, Inc.

"Allocation of Expenses," by Conrad Knerr, Metlab Co.

"Determination of Unit Costs," by John Paterson, Commercial Steel Treating Corp.

"Application of Unit Costs," by Ken Jenks, Lindberg Steel Treating Company.

A talk by Cary H. Stevenson, Lindberg Engineering Company, is scheduled for Wednesday morning, April 7th. Entitled, "How the Commercial Heat Treater and Industrial Furnace Manufacturer Can Work Cooperatively to Their Mutual Benefit," this talk will be welcomed as probably being the first ever presented on the subject.

Other items on the meeting agenda include: consideration of a new draft of the By-Laws of the Institute; a showing of the film, "Tool & Die Making—Keystone of Mass Production," through the courtesy of the National Tool and Die Manufacturers Association; reports by committees; and action upon new and old business of the Institute.

The meeting will conclude with a banquet to be held on Wednesday night.

EASTERN REGIONAL MEETING HELD IN NEW YORK

On February 19th representatives of 15 member companies attended an Eastern Regional Meeting at the Hotel Lexington in New York City. Getting underway early in the morning, the meeting lasted through dinner that evening and had all the elements of a good meeting—techni-

(Continued on page 32)

Heat Treating ABSTRACTS

COMPREHENSIVE STUDY OF TITANIUM NITRIDING

The authors describe work done at the Massachusetts Institute of Technology on cyanide, pack and gas carburizing, straight nitrogen and ammonia nitriding of titanium.

Ammonia Nitriding — Optimum flow rates of ammonia were obtained for a series of temperatures between 1350°F. and 1700°F. It was found that a definite flow rate existed for each temperature which produced maximum diffusion and that greater or lesser rates gave lower total diffusion based on unit weight given. Flow rate proved to be a more practical working measurement than weight gain since variations from the optimum flow rate produced cases which were quite porous.

Nitriding times were determined for each of the temperatures investigated and these times varied from less than two hours at 1700°F. to over 500 hours at 1350°F.

Straight Nitrogen—Among the advantages of using straight nitrogen are the elimination of the explosion hazard and the effects of hydrogen which are not yet completely known. However, it was found that under equivalent conditions the weight gain in nitrogen was only one-half that obtained with ammonia. This was substantiated by lower case depths as recorded by microhardness tests. Furthermore, purification of the nitrogen poses a problem.

Cyanide—A recent patent claims that titanium may be surface hardened by immersion in a molten cyanide bath. However, investigation showed that an extremely rapid rate of corrosion is encountered in this process, particularly if the bath is open to the atmosphere. The process does

(Continued on page 26)

measuring up

...and **REX** is the standard by which <u>all</u> high speed steels are compared

An older brother sometimes makes a handy yardstick for measuring junior's growth. And when it comes to tool steels, REX® High Speed Steel is — and has been for over 50 years — the standard of comparison.

There's no mystery to REX High Speed Steel. Its quality has been time-tested in thousands of shops. And after all, it's performance — not claims — that really counts. Make your *own* comparison test. Put REX High Speed Steel to work. Compare its structure, finish, hardenability, carbide distribution and general uniformity. You won't find another high speed steel that surpasses REX.

Remember, too, that even though it is widely distributed and used, REX High Speed Steel is made *only* by Crucible. So for tops in high speed steel performance, be sure you order the Crucible REX brand.

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Heat Treating Abstracts (cont'd)

not seem to be commercially applicable.

Pack Carburizing—In tests of this method of surface hardening it was found that oxidation, rather than carburizing, tends to occur. Treated specimens were extremely brittle in bend tests and the surface spalled very easily.

Gas Carburizing—In tests using pure helium with various amounts of propane it was found that 1.59 percent propane by volume was the most effective amount used. The case obtained from use of propane proved to be considerably shallower than that resulting from other methods and the case hardness was also disappointing. For these reasons and difficulties resulting from thermal cracking of propane in the furnace used, further test did not appear to be worthwhile.

(Abstracted from, *"Nitriding Produces Better Hard Case On Titanium,"* By J. L. Wyatt and N. J. Grant, *Iron Age January 14, 1954.*)

COMPARISON OF INDUCTION AND GAS HEATING

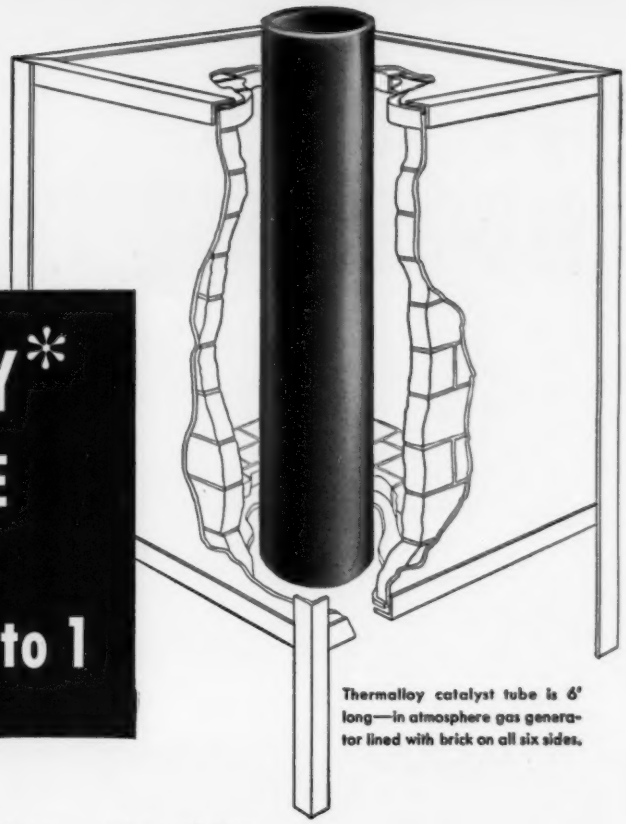
The report describes simultaneous service tests on spur gears made of SAE 1045 steel surface hardened by induction heating and by high-speed direct gas heating.

Gears were tested at two values of peak-load in a "four-square" dynamometer. This type of dynamometer is a closed power system in which the torque is supplied indirectly and the motor supplies only enough power to overcome friction.

Gears were induction hardened on equipment at The Ohio Crankshaft Company. They were heated for nine seconds and quenched for 20 seconds in

(Continued on page 28)

THERMALLOY* CATALYST TUBE outlasts refractory tube 9 to 1



Thermalloy catalyst tube is 6' long—in atmosphere gas generator lined with brick on all six sides.

Another manufacturer is now realizing longer service and less maintenance with heat treating equipment . . . because a Thermalloy catalyst tube was used to replace the refractory tube in an atmosphere gas generator.

The Bowdil Co. of Canton, Ohio, a well-known maker of coal cutting equipment and commercial heat treater uses an atmosphere gas generator to crack natural gas to endothermic atmosphere in a catalyst tube that contains a nickel catalyst. The generator is gas-fired to 1850° F. outside the tube. Previously, a refractory tube was used . . . and *lasted only two months.* Then, Electro-Alloys cast a tube in high heat-resistant Thermalloy. *Installed over 18 months ago,* this Thermalloy catalyst tube is still in operation . . . giving this manufacturer more operating economy in heat treating.

Thermalloy is a group of tough heat-resistant alloys each developed to meet specific high-temperature operating conditions. In the modern foundry at Electro-Alloys, many types of high heat-resistant Thermalloy castings are produced for use as radiant tube assemblies, retorts, trays, fixtures, baskets, rollers. Call your nearest Electro-Alloys representative or write Electro-Alloys Division, 5003 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

Write for new Thermalloy Retorts and Muffles Bulletin T-239.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

Heat Treating Abstracts (cont'd)

a spray of oil with a two second delay between heating and quenching.

The gas hardened gears were pre-heated for two minutes with burners turned low followed by a high heat for 3½ minutes with the burners supplying about 2000 cfh of a 1:10 gas:air mixture. They were then quenched in a water soluble oil mixture.

The following results of the tests were noted:

1. Neither method of hardening resulted in distortion or appreciable decarburization.
2. Differences in structure were noted both in gas hardened and induction hardened gears.
3. The simulated service tests showed essentially the same degree of performance for gears heated by either method.

Abstracted from: "Study of Wear and Service Performance of Gears Surface Hardened by Induction Heating and by High Speed Gas Heating", *a report by Battelle Memorial Institute to the American Gas Association, Project IG-1*

How the Commercial Heat Treater

HELPS HIS CUSTOMERS

Recently a member of the Metal Treating Institute reported an interesting occurrence which is an excellent example of how commercial heat treaters continually exercise care in handling customers' work.

In this case a considerable number of tools was heat treated at the commercial plant and returned to the customer to be finished ground and polished. After completion of these operations it was found necessary that all tools have an oxidized surface and the work was returned to the commercial plant for this operation. However, the purchase order covering the additional work erroneously specified that tools were to be hardened and tempered.

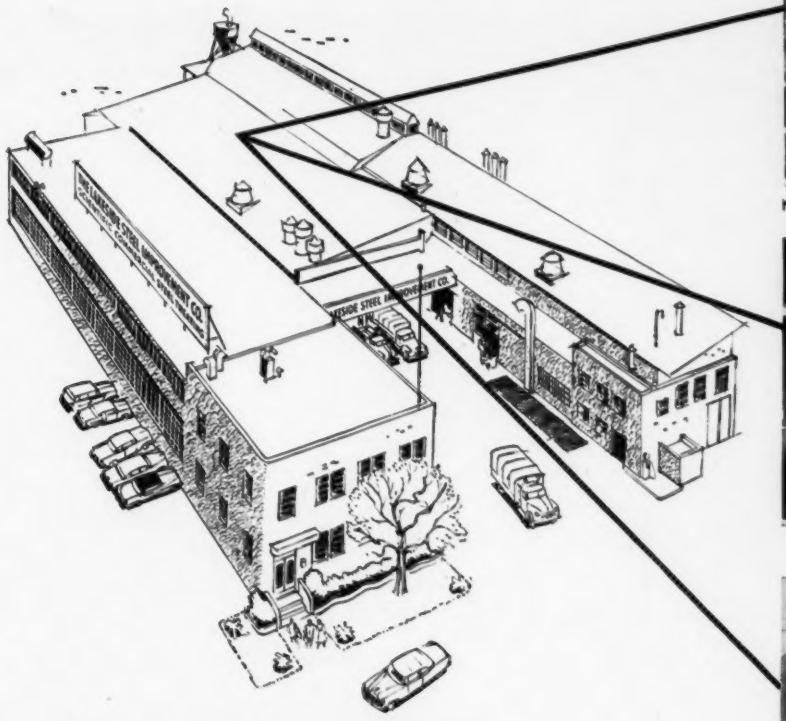
Realizing that the tools covered by this order were the same as those heat treated previously, the commercial heat treater checked with his customer and found that only an oxidizing treatment was desired.

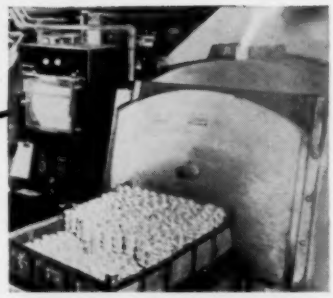
Upon learning this, the commercial plant subjected the tools to a low temperature oxidizing treatment which gave the desired finish.

The heat treater's thoughtful action in checking with the customer on this work saved the customer the cost of the more expensive hardening and tempering treatment. The tools themselves were probably saved also, since hardening might have caused distortion which could not have been compensated for since the tools had been finish ground and polished.

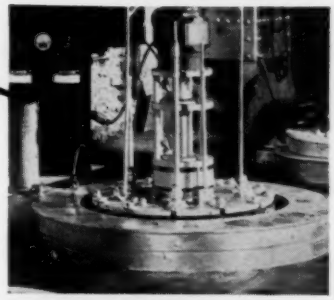
The heat treater in question made the following comment regarding this incident, "Our recommendation entitles us to no medal for honesty. It was simply common sense to sell him (the customer) the correct thing."

Here's where LAKESIDE PUT CARBONITRIDING INTO ACTION!

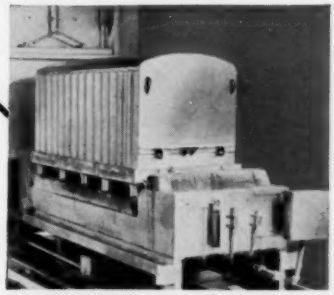




New semi-continuous type furnace at Lakeside



Recently-installed pit-type furnaces



Electric reciprocating furnace at Lakeside

and here's why!

Improved steel treating results for their customers, greater safety and efficiency in their own plant! Those are the reasons the modern Lakeside Steel Improvement Company switched to *carbonitriding* with Armour ammonia.

Lakeside found that carbonitriding hardens steel at lower temperatures, eliminating distortion and cracking. Larger quantities of work can be handled by carbonitriding. Old safety hazards such as poisonous fumes are eliminated. The problem of disposing of toxic waste is gone. With these advantages, it's no wonder Lakeside put 10 carbonitriding furnaces into action. And it's no wonder that Lakeside called on Armour, who had helped them with installations, to supply them with pure, dry, dependable Armour ammonia.

Experienced men in Armour's Technical Service Department are equipped and ready to help you in your installation of these new processes.

Since 1947 Armour has sponsored a fellowship at the Massachusetts Institute of Technology for the study of carbonitriding and other modern metal treating processes. That knowledge is basic research, and available to you.

The booklets offered at right will show you how to put this knowledge to work in your plant. Write today for free copies. If your problem is unusual or pressing, write us today giving full details of your requirements.

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Please send me free copies of the items I have checked:

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T3

cal talks, a group luncheon and tours through MTI member plants in the vicinity.

During the morning session Mr. C. W. Kiettel of Baker & Company, Inc., Newark, N. J. addressed the group on the use of "Nitroneal" gas in heat treating. His talk was followed by the comments of Fred Heinzelman, Jr., about the Nitroneal gas generator in use at the Heinzelman plant.

At this same session Mr. H. W. E. Riley of Polyplastex International, Inc., New York, N. Y. presented a talk entitled, "Casting Impregnation—A Future Business for Commercial Heat Theaters." In his talk Mr. Riley discussed in detail the mechanics of impregnation, equipment required, market potentials and license arrangements.

After a group luncheon, everyone boarded a Greyhound bus for visits to the plants of Metro Heat Treat Corp., Fred Heinzelman & Sons and Alfred Heller Heat Treating Co., Inc.

Following dinner in the evening, Mr. Al Cox gave a short talk, illustrated with slides, on the impregnation equipment made by the J. P. Devine Manufacturing Company.

The presence of President Cliff Cook as well as a number of members outside the eastern area contributed greatly to the success of this meeting. This was Mr. Cook's second visit to a regional meeting this year and it appears that he is well on his way toward achieving the aim of visiting all MTI members during his presidency.

OPEN HOUSE AT NEW LINDBERG WEST COAST PLANT

To celebrate the opening of its new plant in Los Angeles, California, the Lindberg Steel Treating Company held an "Open House" there on November 20, 1953. Total attendance at the affair numbered 735 people, many of whom represented various airframe manufacturers on the west coast.

Each piece of equipment at the plant was identified to let guests know what process it was used for. Samples of heat treated parts were on display along with a large number of photographs showing parts which were handled previously. A buffet supper was held during the evening after guests had the opportunity of touring the new plant.

Robert W. (Bob) Fish, Manager, and all employees of the plant acted as hosts for the occasion. On Hand from Chicago were Roy Lindberg, Ken Jenks, A. Uitti, Norman Kates, Ed Sommer and Harry Magnussen.

A view of the entrance to the new plant is shown in the photograph below.

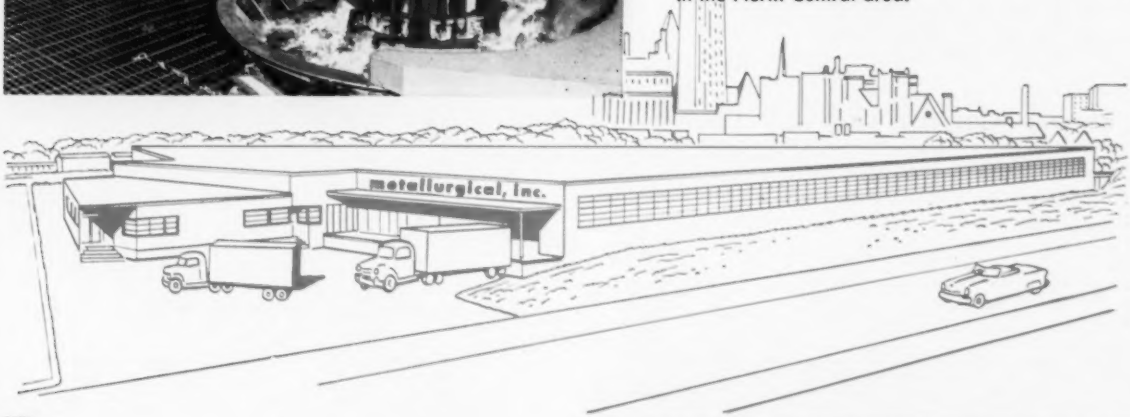
(Continued on page 34)

The Park Triple A Story:

"Park Quench Oil gives us faster, deeper hardening with much less distortion,"

says AL RIDINGER,
President of METALLURGICAL, INC.

At Metallurgical's new 40,000 sq. ft. plant in Minneapolis, Al Ridinger (right) shows Charles Wesley (left), President of Wesley Steel Treating, Milwaukee, a quenching process as Larry Ridinger (center), Company Vice President, looks on. Here, wing flap tracks for B-47 Jet Bombers are being quenched in a modern 8000 gallon system in which Park Triple A oil is circulated at the rate of 2000 gallons per minute. Using the latest type equipment, Metallurgical serves over 28 major industries in the North Central area.



PARK TRIPLE A QUENCH OIL was developed specifically to *cool steel faster* in the upper temperature ranges, giving higher and deeper hardness. The final stage of cooling is *slow and uniform* for the best surface hardness and depth of hardness penetration without danger of warping or cracking. *Extremely stable,* Park Triple A is not subject to breakdown, saponification or rancidity.

Higher hardness, less distortion and longer life —Park's *Triple Action* Quench oil . . . suitable for use as a quench from any heat treating medium . . . highly recommended for obtaining maximum hardenability.

• Liquid and Solid Carburizers • Cyanide, Neutral, and High Speed Steel Salts • Coke • Lead Pot Carbon • Charcoal • No Carb • Carbon Preventer • Quenching and Tempering Oils • Drawing Salts • Metal Cleaners • Kold-Grip Polishing Wheel Cement

Park **PARK CHEMICAL CO.**
8076 Military Avenue • Detroit 4, Michigan

Send free bulletin describing Park Triple A Quench Oil.

Name_____ Position_____

Company_____

Address_____

City_____ State_____

Fourth in a series of advertisements describing Park processes on the job.

METALLURGICAL, INC. OPENS NEW MINNEAPOLIS PLANT

More than 1,000 people from all parts of the country visited the new ultra-modern metal treating plant of Metallurgical, Inc., Minneapolis, Minn., during a grand opening celebration on January 22, the 10th anniversary of the firm.

The new Minneapolis plant, which employs over 100 people, has 67,000 square feet of area, including trackage. It incorporates all of the latest equipment for the treatment of ferrous and nonferrous metals.

A pit 100 feet long, 15 feet deep and 14 feet wide takes up a large portion of the plant. One of the furnaces in this pit is a Hevi Duty electric furnace which has a capacity of up to 6,700 pounds per load. It is used for bright annealing, normalizing and carburizing, and is atmosphere-controlled to insure bright, scale-free work.

Two Surface Combustion radiant tube gas fired furnaces are also housed in the pit. Each has a capacity of up to 4,300 pounds per load and both are atmosphere controlled. These furnaces each have an oil quench tank located next to them with a Bell & Gosset recirculating system which changes the oil at the rate of 2,000 gallons per minute.

An atmosphere-controlled electric furnace with a capacity of 4,100 pounds per load, and a Lindberg Tempering Furnace make up the other furnaces in the pit. The tempering furnace is also used for solution heat treating of large aluminum parts. A water tank, located next to the furnace for aluminum quenching, has a capacity of 6,200 gallons.

Fig. 1—Watching a basket of washers roll into an Ipsen furnace for hardening are, left to right, Gerald L. Moore, president of the Minneapolis Chamber of Commerce; J. R. Cottell, president of the Continental Electric Equipment Co., Cincinnati, Ohio; Clifford Cook, president of the Metal Treating Institute, Houston, Texas; Al Ridinger, president of Metallurgical, Inc.; and J. R. MacAllister, president of Syracuse Heat Treating Corp., Syracuse, N. Y.

Fig. 2—Al Ridinger, president of Metallurgical, Inc., Minneapolis, center, points out the method used by his firm in treating steel flaps for B-47 Strato-Jet bombers, during the grand opening of the new Metallurgical plant on January 22. A fixture of the steel flaps is shown being immersed in an oil quench tank after being removed from the Surface Combustion furnace at the right.

One section of the plant is occupied by a General Electric Neutralene generator which provides a protective atmosphere for all of the pit-type furnaces and all automatic hardening and brazing furnaces. It produces 4,000 cubic feet of neutralene atmosphere per hour and insures a clean finish on all work without scaling or oxidation. A large Westinghouse generator which produces an endothermic type atmosphere has been installed as a stand-by unit.

Arranged in a smaller pit along the plant floor are several different types of furnaces for treating various types of metals or for specific hardening and tempering jobs.

A Leeds & Northrup Microcarb furnace, which is used for carbon restoration, is housed in this pit. The rest of the pit is taken up by a water quench tank and four Lindberg Cyclone draw furnaces which are used for drawing and tempering steel and aluminum parts.

A bank of three Ipsen furnaces heads another line followed by two pusher-type brazing furnaces which are gas fired and atmosphere-controlled for bright annealing, normalizing and air hardening tool steels.

General Electric and Sergeant & Wilbur continuous belt type furnaces are positioned next to the brazing furnace. These two furnaces are used for copper brazing, silver soldering, bright annealing and hardening.

Selective hardening is done with a Cincinnati Flamatic machine. The heat is supplied by flame heads burning natural gas through adjustable gas tips. The hardening temperature is set on a recording instrument using an optical pyrometer

positioned over the part.

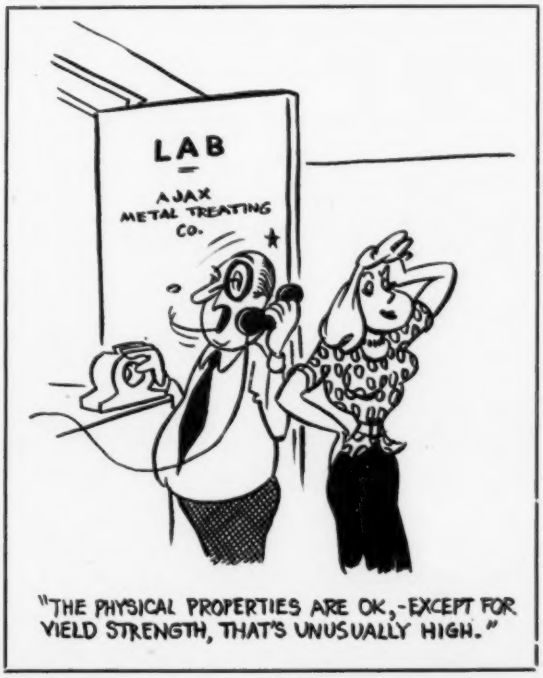
Selective hardening, annealing and brazing are also done with two induction units, one is a single station type and the other has two stations.

There are six salt bath furnaces at the plant. Two of them have a neutral bath for hardening tool steels and alloy steels. Two isothermal quench furnaces are used for martempering and austempering, and have a combined quenching range from 275°F. to 1100°F. The other two furnaces are Ajax liquid carburizing salt baths for surface hardening.

Another section of the plant is devoted to aluminum heat treating. In this area, various grades of aluminum that respond to heat treating are solution heat treated and age hardened. The solution heat treating is done in two salt bath type furnaces from which parts are quenched in water.

Six semi-trailer trucks can be accommodated at one time by the plant's 60-foot loading dock and turn-around driveway. New facilities of the Minneapolis plant, combined with those of its Kansas City branch, give Metallurgical, Inc., more than 160,000 square feet of ground area, and represents a multi-million dollar investment in metal treating facilities in the North Central States. Both plants operate 24 hours a day, seven days a week.

The firm was started on January 22, 1944 by A. T. Ridinger in part of a vacant garage in south Minneapolis, with only two second-hand furnaces and three employees. A rigid adherence to the basic principles of quality workmanship an unexcelled service during the past decade resulted in a phenomenal growth of Metallurgical, Inc.



Effect of Contamination With Water and Air

In order to determine whether it was necessary, or desirable, to exclude air, a series of tests was run to determine any adverse effects of air and water vapor. From the results of these tests it appears that precautions to eliminate air and water vapor are not necessary. The only effect noticed was that an excess of water would stain the nitrided surface to some extent and impair its appearance; however, it could be easily polished to a bright finish.

Table III—Effect of time on properties of nitrided cases.

Property	Hours at Temperature				
	4	15	45	60	90
			Type 135		
Total case	0.0085	0.0095	0.0190	0.0180	0.0212
	0.0070	*0.0120*	*0.0200*	*0.0190*	*0.0240*
Maximum hardness	1180	1225	1195	1225	1185
	1225	*1250*	*1215*	*1195*	*1160*
Depth over 700 D.P.N.	0.0032	0.0062	0.0150	0.0163	0.0197
	0.0033	*0.0067*	*0.0148*	*0.0161*	*0.0195*
White layer	0.0003	0.0005	0.0011	0.0004	0.0007
	0.0003	*0.0007*	...	*0.0005*	*0.0005*
			Type N		
Total case	0.0090	0.0105	0.0185	0.0190	0.0235
	0.0055	*0.0095*	*0.0190*	*0.0160*	*0.0240*
Maximum hardness	1035	1130	1150	1150	1100
	1065	*1130*	*1010*	*1125*	*1100*
Depth over 700 D.P.N.	0.0034	0.0064	0.0144	0.0162	0.0196
	0.0028	*0.0069*	*0.0128*	*0.0128*	*0.0146*
White layer	0.0002	0.0004	0.0010	0.0003	0.0008
	0.0002	*0.0006*	...	*0.0004*	*0.0005*

Ammonia Consumption

It was stated previously that ammonia consumption could be reduced as much as 95% by using the high pressure process in preference to the conventional process. Typical published values of ammonia requirements are 20 to 30 cubic feet of of ammonia vapor per hour per 100 square feet of surface nitrided. [2] [4] Comparing these ammonia requirements with those for Type N and Type 135 at a nitriding time of 45 hours, where a case depth of approximately .019" is obtained by both processes, the conventional process requires 40.5 to 60.8 pounds of ammonia per 100 equare feet of surface nitrided for 45 hours, while the high pressure process required only 2.2 pounds per 100 square feet nitrided for 45 hours to give an equivalent case; this represents a reduction in ammonia consumption of 94.5% to 96.3%. Equal results have been obtained with only 1.1 pounds of ammonia per 100 square feet.

Nitriding Containers

It has been pointed out rather frequently in the literature that common carbon, or low alloy, steel containers are unsatisfactory for nitriding by the conventional process. This has not proven to be a difficulty when nitriding under pressure. SAE 1020 steel tubing has been used for containers for nitriding other parts, on the outer surface. Since the reaction of ammonia is reversible under the conditions of high pressure nitriding, any influence that common steels may have on the rate of ammonia dissociation does not appear to be significant to the final result.

Comparison With Conventional Nitriding Processes

An objectionable feature of the nitrided case obtained by the conventional process is the so-called "white layer" which forms on the surface. This white layer generally is of the order of .001" to .002" in thickness and is relatively much more brittle than the remaining portion of the nitrided case. A comparison of photomicrographs of nitrided cases, obtained by the conventional process and by the pressure process, is shown in Fig. 8. Fig. 8-A shows a typical nitrided case resulting from conventional nitriding of Type 135 steel for 90 hours. The white layer shows plainly at the top of the photomicrograph, which represents the outer surface of the nitrided case. A microhardness indentation in this white layer resulted in a distinct crack. Fig. 8-B shows a sample of identical material nitrided for 90 hours, at a pressure of 800 psi. It will be noted that the indication of a white layer in Fig. 8-B shows a definite metallic structure up to the surface.

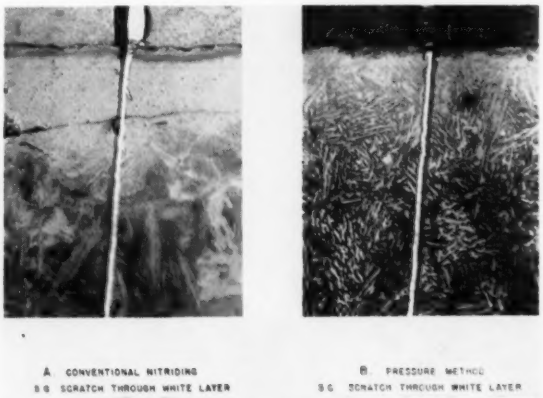


Fig. 8—A comparison between "white layers" on conventional and pressure nitrided Type 135 steel.

A comparison of conventional nitriding for 90 hours with pressure nitriding for 45 hours on Type 135 steel showed that total case thickness was approximately .005" greater with the 90-hour cycle but while the average maximum hardness for samples nitrided by the conventional process was 1082 DPN, the average of samples nitrided under pressure was 1205 DPN. This is a very significant difference in hardness and should be reflected in superior wear resistance.

Within the last few years, a two-stage cycle of nitriding* has been used to some extent in an effort to eliminate the objectionable effects of the white layer obtained by conventional nitriding. The two-stage cycle is started at a relatively low temperature of perhaps 975° F. and held for a few hours while circulating ammonia at a rate to give a relatively low percentage dissociation (approximately 15% to 25%); the temperature is then raised to 1050° F. for the remainder of the cycle and ammonia dissociation is maintained at around 85%. An auxiliary ammonia dissociator is often utilized for the latter part of the process. Table IV shows a comparison of 25-hour and 35-hour two-stage processes and a 15-hour pressure process at 800 psi. The maximum hardness obtained with the pressure process is again considerably greater than with the two-stage process and a greater "superhard" case is obtained in 15 hours under pressure than in either 25 or 35 hours with the two-stage procedure.

Table IV—Comparison of results obtained with two-stage nitriding and pressure nitriding.

	Nitriding Time	Material	Maximum Hardness (DPN)	Depth of Superhard Case (>775 DPN)
2-Stage Cycle	25 Hrs.	135 Mod.	1015	.0045"
	35 Hrs.	135 Mod.	1140	.0055"
800 psi	15 Hrs.	135	1250	.0064"

Typical of the parts which have been successfully nitrided by the "Nitrocycle" process is a power piston for a subsurface hydraulic pump unit in which the valves for distributing power oil are mounted within the piston. There are numerous longitudinal and transverse passages through which it would be impossible to obtain adequate circulation to produce satisfactory nitriding with the conventional atmospheric pressure process. Extremely close tolerances are required in order to fit the piston valves and other parts, after nitriding, with sufficient accuracy. Practically no distortion occurs during this hardening process. It would not be possible to case-harden the flow passages of this item by any means requiring quenching inasmuch as the high temperature required would result in relieving of press fits; air would be trapped in the passages to prevent contact with the quenching fluid, and quenching would very likely result in sufficient distortion to render the part useless.

In conclusion, we wish to point out that the techniques described above for nitriding under relatively high pressures have proven to be extremely satisfactory with a minimum investment in equipment and a minimum requirement for skilled supervision. A uniformly satisfactory product is obtained and the cost of nitriding is greatly reduced in comparison with the conventional nitriding process. ■ ■ ■

* *Carl Floe Method*

ACKNOWLEDGMENT

We wish to express our sincere appreciation to Mr. F. Lee Current and other members of the Research Staff for valuable assistance with various phases of this investigation. Mr. C. W. Lindquist made the microexaminations and hardness determinations necessary for the data reported in this paper, and Mr. W. L. Culbertson contributed much of his time to the long series of tests necessary for the accumulation of the data.

We wish also to acknowledge the cooperation of Management in making this investigation possible and the Manufacturing Department in adapting this nitriding process to commercial products. Mr. R. L. Stone has been very generous in making available the equipment in his department for pilot runs that could not be made in the Laboratory.

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The processes used in the high pressure method for nitriding described in this paper are covered by United States Patent No. 2,596,981, and additional United States and foreign applications.

LETTERS TO THE EDITOR

Gentlemen:

Our company has been receiving your magazine "Metal Treating" and it has been distributed throughout our plant. However, there are times when I would like to retain our company's copy for my own personal file. The information which is published is excellent and I, as well as others of our organization, would like to be placed on your mailing list.

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I have seen the January-February 1953 issue of your publication "Metal Treating." I am impressed with the high grade of the information carried in this magazine.

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MANUFACTURERS' LITERATURE

The literature listed below contains information of interest to heat treating organizations. For your Copy write direct to the manufacturer and be sure you mention seeing it reviewed in "METAL TREATING".

INDUCTION HEAT BULLETIN

A new eight-page bulletin on forging with induction heat has been announced as available from the General Electric Company, Schnectady 5, N. Y.

Designated GEA-5983, the two-color publication outlines the prime benefits of induction heat as utilized in the forging industry. Included are a series of case histories, well illustrated, covering various on-the-job applications.

Frequency-time-work diameter charts are provided as an aid in determining power requirements.

GAS AND LIQUID FLOW CONTROL

A new catalog describing process control instruments has been announced by Fischer & Porter Company, 924 Jacksonville Road, Hatboro, Pennsylvania. The catalog lists a variety of flow meters, recorders, controllers, pressure regulators, sight flow indicators, and chemical feeders, giving discounts from list price as well as additional quantity discounts. Complete instrument specifications are set forth. Sizing nomographs for the two most common types of Flowrator meters are also given covering both liquid and gas service.

CONTROL INSTRUMENTS

A new bulletin, F 5633-1, describing the complete line of Wheelco instruments for industrial control applications is available from Wheelco Instruments Division, Barber-Colman Company, Rockford, Ill. Included is a discussion of the company's "electronic link", a no-contact linkage between the direct measuring unit and the automatic control and recording system which is said to give instantaneous control and recording action.

FIRE CONTROL

Ansul Chemical Company, Marinette, Wis., is making available its entire list of fifteen technical bulletins covering recommended procedures for protecting many difficult and unusual fire hazards. The list of bulletins includes: No. 8—"Fires in Molten Salt Hardening Baths" and No. 26—"Recommended Fire Protection of Liquified Petroleum Gas Storage, Unloading and Processing Areas."

STOCK CONTROLLERS

A new 2-page bulletin, No. P1262, listing furnace and oven control instruments which are carried in stock has just been published by The Bristol Company, Waterbury, Conn. These stock instruments include indicating pyrometers and controllers for permanent mounting or portable use, indicating thermometer controllers, traveling oven recording thermometer and Pyrotol combustion safeguards. Other control accessories, such as thermocouples and protection tubes, and Bristol's potentiometric test set, are also shown.

STAINLESS STEEL SELECTOR

A new slide rule-like chart which answers the question of what type of stainless steel should be used for about 95 per cent of all operations requiring stainless is being distributed by Crucible Steel Company of America through its branch offices.

The stainless steel selection method covered by the chart, designed especially for the use of fabricators, designers, purchasing agents and others who do not have metallurgical training, was developed by Hugo Becker, Assistant Product Manager for Crucible's tool steel products. Mr. Becker designed a similar chart for the selection of tool steels in April of 1950.

Becker's chart grew out of Crucible's findings that most stainless metal-working failures and losses result from wrong selection of stainless steels. Such failures can be a great hardship to smaller business and metal-working organizations, according to J. D. Glenn, the company's Stainless Steel Division sales manager.

The use of the chart approaches the problem in much the same way as the metallurgical engineer in selecting the proper stainless steels for an application. The front contains a comparison of stainless physical and mechanical properties, and elevated temperature properties. The reverse side gives a large number of the important characteristics of stainless. The chart cannot be designed to cover all cases. The rarer jobs require the special knowledge of a competent metallurgist for specific advice.

VERTICAL TYPE MUFFLE FURNACE

The Atmotrol vertical type muffle furnaces are described in a new bulletin just released by Surface Combustion Corporation, Toledo 1, Ohio.

Bulletin SC-165 includes a detail construction drawing, depicting important design features, photographs of typical applications with types of parts being heat treated, and descriptions of accompanying equipment-controlled cooling pits and prepared atmosphere generators. Engineering data and charts on the application of RX atmospheres to heat treat processing are also included.

CASEHARDENING

A booklet covering the use of ammonia in the casehardening of steel is being offered by Armour and Company, Ammonia Division, 1355 W. 31st St., Chicago, Ill.

Titled "Casehardening of Steel by Nitriding," the 32-page booklet was prepared by M. B. Bever and C. F. Floe of the Department of Metallurgy, Massachusetts Institute of Technology.

Pictures, charts and tables are included in the booklet which is another in a series prepared for users of anhydrous ammonia.

DESIGNATION CHART FOR CARBON AND ALLOY STEELS

A designation chart, Bulletin 253-I.A, for carbon and low alloy steels has been issued by Empire Steel Castings, Inc., Reading, Pa. It identifies the Company's Isocast carbon and alloy castings with A.S.T.M., Federal, Navy, A.I.S.I., and S.A.E. specifications. In addition, the chart gives the chemical analysis, mechanical properties, heat treatment and uses of the eighteen steels listed. Mechanical properties of three types—Isocast 5, 8, and 9A are charted for reference.

MULTI-POINT RECORDER-CONTROLLER

A four page technical data bulletin covering Multi-Point circular chart recorders has been prepared by Fielden Instrument Division, Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Phila. 33, Pa. It describes and illustrates the new design features said to make this unit unique in the field of circular chart recorders. Fielden's exclusive "Turret" pen assembly makes possible six individual records on a single circular chart. Through a "Segmental" chart drive unit, the instrument becomes either a 24, 48, or 96 point Multi-Record system. Construction features and specifications are also included.

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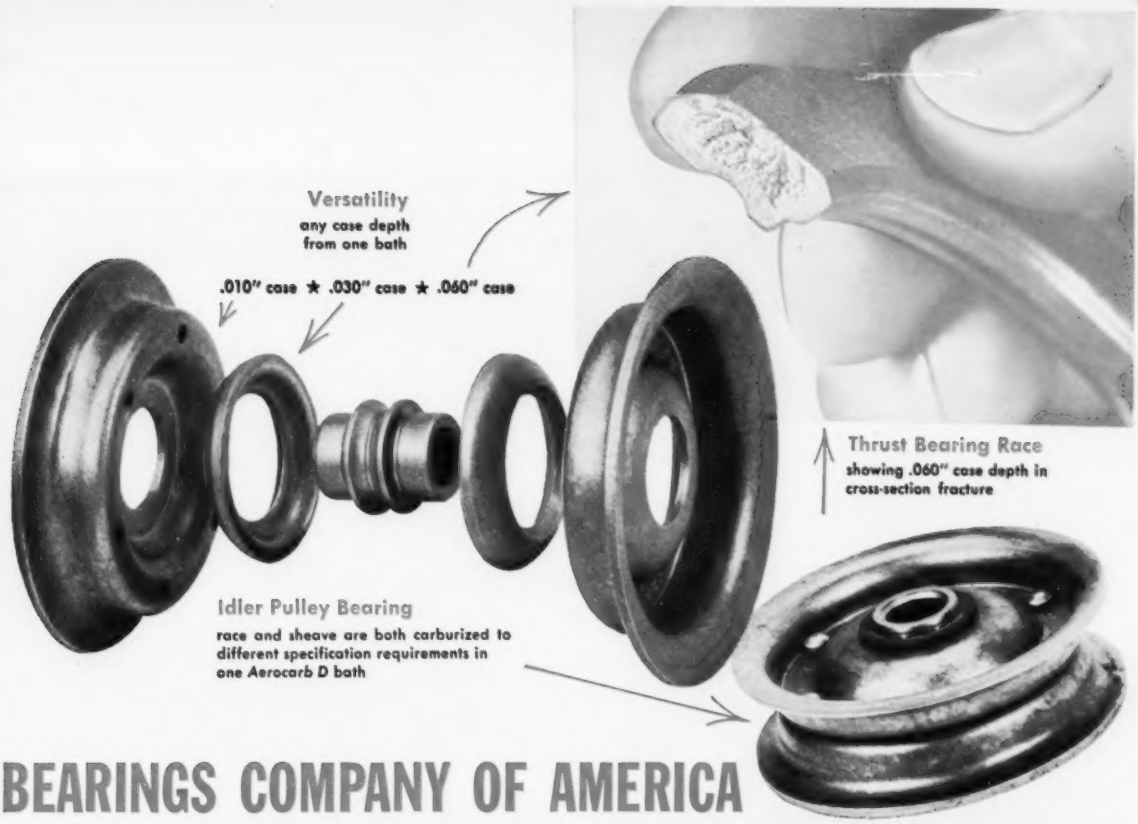

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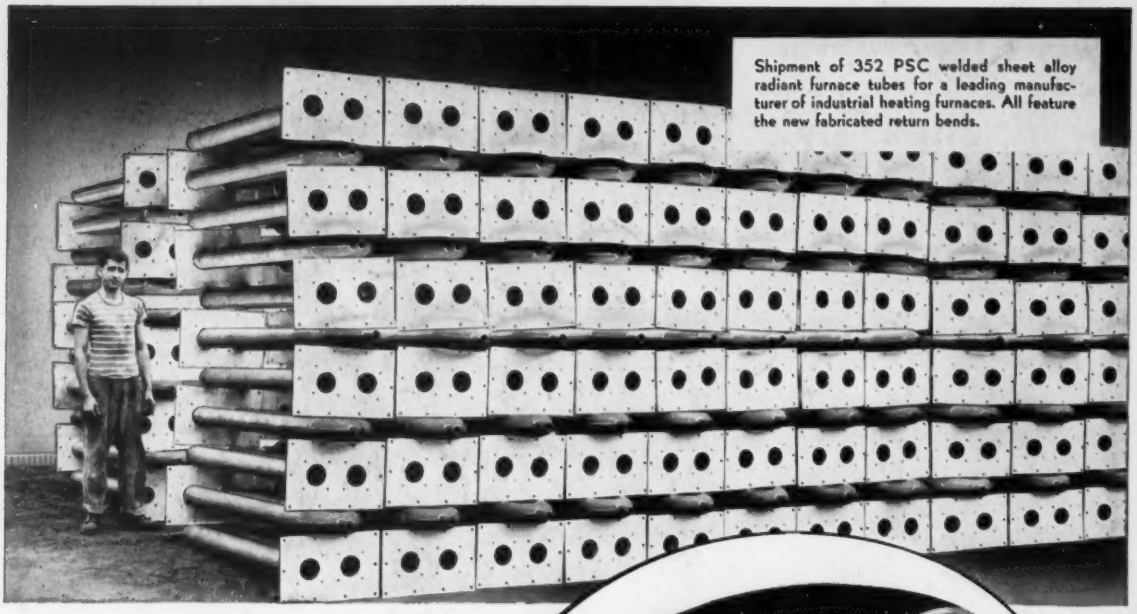

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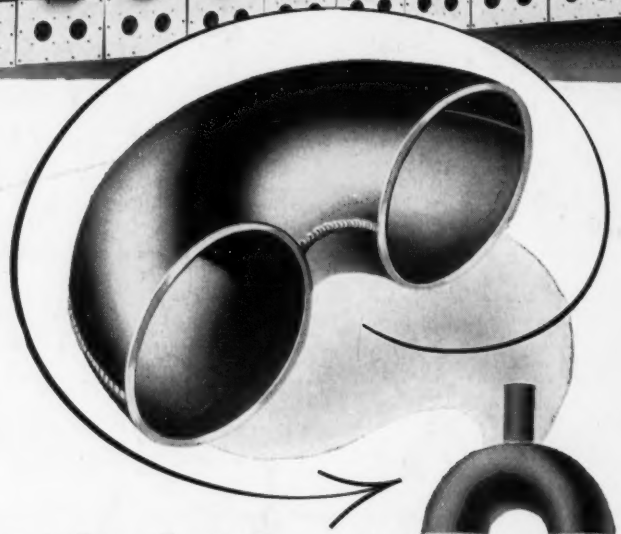

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